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CONTENTS

Cognitive Strategies in Native Children: Analysis and Intervention	271
<i>L. W. Krywaniuk and J. P. Das</i>	
Science Concepts in Semantic Space—A Multidimensional Scaling Study	281
<i>P. F. W. Preece</i>	
Problems of Control in Nonexperimental Educational Research	289
<i>T. O. Maguire and B. D. Haig</i>	
Effects of Data Classification on Mind Set of Grade Six Students	297
<i>I. Wright and F. Simon</i>	
Educational Feasibility Studies: A Conceptual Framework	305
<i>W. E. Hathaway</i>	
Alberta Advisory Committee for Educational Studies—Funded Research	311
Cultural Variables in Conservation: A Model for Cross-Cultural Research	315
<i>A. Mohanty and L. L. Stewin</i>	
Functional Reading Levels: From Graded Word Lists?	325
<i>V. Froese</i>	
The Disturbing Child: What You See is What You Get?	330
<i>R. Algozzine</i>	
Family Socialization and Adolescent Behavior: A Canonical Analysis	334
<i>K. Marjoribanks and H. J. Walberg</i>	
List of Books Received	345
Table of Contents for 1976	346

FACULTY OF EDUCATION
The University of Alberta

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Cognitive Strategies in Native Children: Analysis and Intervention

Forty Canadian Indian children in grades 3 and 4, designated as low achievers, were given a set of cognitive and intelligence tests including WISC. It was found that the children had inefficient sequential learning processes. The children were then divided into two groups and received a minimum and a maximum remediation program to improve sequential strategies. The main finding in the group receiving maximum remediation was a significant improvement in sequential tasks such as auditory and visual memory and reading tests. Learning strategies can thus be modified by appropriate remedial programs to enhance cognitive competence. (Dr. Krywaniuk is Assistant Professor in the Department of Special Education, The University of British Columbia; Dr. Das is Director of the Centre for the Study of Mental Retardation, Faculty of Education, The University of Alberta.)

North American Indian children generally show a low verbal development when compared with the national norms, but often have average or above average performance abilities (Cazden & John, 1968). This has been associated with a visual style of learning (Havighurst, Gunther & Pratt, 1946) and with the fact that the child may suffer from first language interference of English development (Cazden & John, 1968). There has, however, been very little work done on the ability patterns among native children. One suspects that school success depends heavily on a certain pattern of abilities rather than on a single one, and that failure in school is based on the styles of learning employed (Havighurst, 1970).

Several studies have demonstrated that variations in the patterns of cognitive abilities exist among ethnic groups (Lesser, Fifer & Clark, 1965; Stodolsky & Lesser, 1968). We have chosen to focus on two broad cognitive abilities—simultaneous and successive. Previous work (Das, 1973a, 1973b; Luria, 1966a, 1966b) indicates that the two categories include a broad range

of memory and reasoning tasks. Successive and simultaneous syntheses as modes of information processing was first mentioned by Luria (1966a, 1966b). His extensive observations of the psychological effects of brain lesions led him to suggest that the two types of integration are located in specific parts of the brain: the parietal-occipital (simultaneous) and fronto-temporal (successive) lobes. Das (1972) has assumed Luria's basic conceptualization and has found evidence that the simultaneous and successive strategies to some extent are used at the discretion of the individual (Das, 1973b).

However, no task is purely simultaneous or successive, but involves elements of each, and can be approached with some combination of both strategies. It is in this combination where individuals, and indeed cultures, vary. Das has shown that different individuals and groups vary in their approach to specific tasks. This evidence suggests that the strategies are learned and differences in cognitive functioning are based on the appropriateness of the strategies used. The importance of this finding lies in the fact that as strategies are learned, they can be taught and can therefore be changed where they are inappropriate. This aspect is the focus of the present study.

Method

Subjects

Forty grade 3 and 4 students at Ermineskin School in Hobbema, an Indian reservation 50 miles from Edmonton, were used in the study. The subjects, as a group, were rated by teachers as constituting the lowest third of the class in terms of school achievement.

Tests

A battery of tests¹ was given to each subject. The tests were: Wechsler Intelligence Scale for Children (WISC), Raven's Progressive Matrices, the Figure Copying Test (FCT), Memory for Designs test (MFD) developed by Graham and Kendall (1960), a Serial Learning test (Orn & Das, 1972) using lists of acoustically and semantically similar words presented on tape, a Visual Short-term Memory test (VSTM) using random numbers presented in a five-cell matrix in the form of a cross by a slide projector (Orn & Das, 1972), the Stroop test (Stroop, 1935), a modified form of the Birch and Belmont (1965) Cross-modal Coding test (CMC) which presented patterns of auditory sounds for visual recognition, and the Schonell Graded Readiness Vocabulary test. Raw scores were used for the Raven and Schonell tests. Serial Learning and VSTM tests were scored both for serial position and free recall of items.

Results

A summary of the pretest scores is found in Table 1. The results of the pretest scores were analyzed so that a remediation program could be designed. As was anticipated, the group scores on the WISC indicated low verbal abilities, but also higher (within average range) performance abilities. When the Raven scores were converted into percentiles, it was found that slightly more than half of the group was above the fiftieth

TABLE 1
MEANS OF PRETEST SCORES

Test	Mean	SD
WISC Verbal	78.05	11.70
Performance	93.39	12.24
Full Scale	83.66	11.57
Progressive Matrices (raw scores)	23.08	4.05
Schonell (raw scores)	27.81	11.21
Cross-modal Coding (out of 20)	10.79	4.09
Figure Copying (out of 20)	12.08	2.19
Serial Learning (out of 192)		
Serial Position Recall	91.52	31.01
Free Recall	126.05	29.52
Memory for Designs (error score)	3.81	2.80

percentile. The high WISC Performance scores and the Raven scores suggested that these children had adequately developed spatial abilities. On the other hand, the WISC Verbal and the results on the Schonell and Serial Learning tests suggested difficulties in the verbal area.

Consistent with the theoretical assumptions stated earlier, these findings indicated good simultaneous strategies but poor successive strategies in cognitive operations. It was felt that the inefficient successive strategies could be improved by an appropriate remedial program. Thus, an appropriate intervention program was designed. Its effect was evaluated by dividing the sample into two groups of subjects matched on the WISC scales. Group I (Experimental) was given a treatment consisting of approximately 15 hours of remedial experience, and Group II (Control) was given a minimum treatment consisting of approximately three hours of experience.

Intervention Procedure

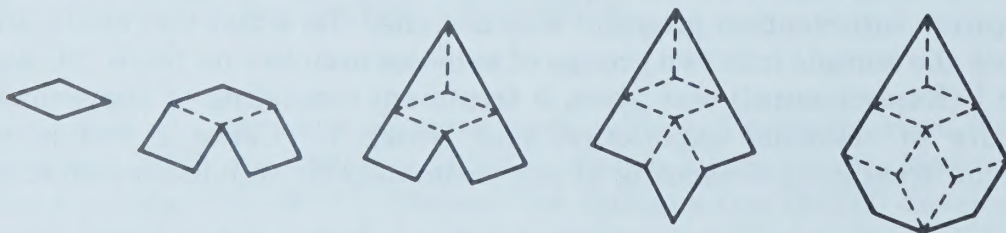
A brief description of the intervention is provided here. The objective of the program was to improve the use of successive strategies by the subjects; the improvement expected in the experimental group would be significantly greater than that in the control group. Subjects were trained in the following tasks with appropriate instructions in order to facilitate their use of sequential strategies.

In the remediation program, verbalization was encouraged in the development and use of memory and recall strategies. It has been suggested (Jensen, 1971; Sperling, 1963) that both visual and auditory stimuli are encoded verbally into a single short-term store. Whereas adults spontaneously organize and encode in this fashion, children do not (Bernbach, 1967; Kingsley & Hagen, 1969), although they can do so if they are instructed (Jensen & Rohwer, 1970). These findings are consistent with the theoretical assumptions presented earlier and with Luria's (1961, 1966a, 1966b) conceptualization of verbal mediation.

Sequence Story Boards. There were three separate stories, each consisting of 12 pictures which could be arranged to tell a complete story. The

completed form took the form of three rows of four pictures each, similar in arrangement to a page of printed material. On three separate occasions the child was given one story (12 pictures) in random order and asked to arrange the pictures into the prescribed format. He was encouraged to examine each picture and to verbalize during their arrangement. A minimum of help was given; usually an indication of the first picture was sufficient where any help was needed. The child was also required to tell the completed story. Anomalies in the arrangement were pointed out, and the child was required to correct them and proceed toward the end until the complete story was told.

Parquetry Designs. The materials for this task consisted of a number of squares, triangles and rhombuses of various colors, which could be fitted together to form visual patterns, as well as templates providing the patterns to be made. At first, the child built patterns by placing colored tiles directly upon the colored template, then proceeded to construct patterns by using the colored templates only as a reference. For subsequent sessions, color was removed as a cue, along with the internal lines. Several series of outline forms were developed, one of which is presented below. Each outline form was presented on a separate sheet of paper. The series progressed by the addition of more and more pieces to an already completed pattern. In each case, the total pattern was to be reconstructed. The most efficient strategy was to remember the relationships involved in the previous pattern and then add new pieces. Each subsequent series presented was more difficult than the previous one and thus reinforced the importance of memory as a strategy.



1. Parquetry Designs

Serial Recall. In this task 12 common objects were shown to a child for a short time and then taken away. The child was required to recall as many objects as possible. As each one was recalled, it was placed in front of him. He was shown the remaining articles and again they were removed. This procedure was repeated until he could name all objects. In the second presentation, 12 different objects were used. The child was encouraged to group them according to some criterion before they were removed. They were then recalled in the procedure described above.

Coding. Hand and knee "claps" were coded as dots and squares, respectively, and presented in rhythmic patterns similar to those on the Cross-modal Coding test. Each pattern was presented separately and the child was expected to "decode" the pattern into the appropriate rhythm of claps. The series of patterns was graded in difficulty. Some examples are provided below.

Matrix Serialization. During the administration of the Visual Short-term Memory test, it was noticed that the children did not have a consistent recall

(a) □ □ ● ●

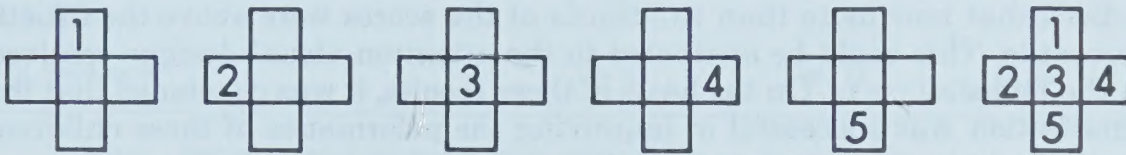
(c) □ ● ● □

(b) ● □ □

(d) ● ● □ ● ●

2. Hand “claps” (dots) and knee “claps” (squares) sequences

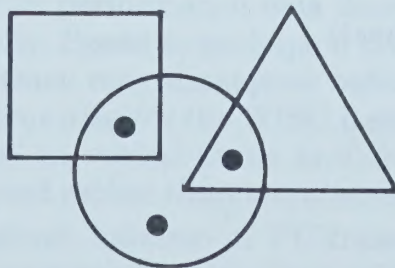
pattern in terms of spatial organization. For this reason, it was decided to establish a search and recall pattern consistent with the reading pattern: top to bottom, left to right. To achieve this, several series of matrices were developed, as shown, that were identical in format to those used in the Visual Short-term Memory test. The first five matrices in any one series were presented singly, and the child was required to read each number as it appeared. He was asked to repeat the whole series from memory, in the order presented. He was then shown the complete matrix for confirmation. If he made an error, he read the correct series aloud from the complete matrix and then recalled it again. The number sequences were graded in difficulty. In later sessions, he was shown only a complete matrix and was asked to read it in the prescribed order, and then recall it.



3. Successive matrices for teaching serialization strategy

Filmstrips. A total of five filmstrips were prepared: Visual Discrimination and Spatial Orientation, Visual-Motor Co-ordination, Visual Memory, Figure and Ground, and Visualization. These filmstrips formed the basis of the Group II intervention and were also done by Group I. As in all the intervention tasks, verbalization was encouraged. One of the filmstrips (Figure and Ground) will be described below.

Each filmstrip consists of approximately 36 frames, graded in difficulty, and building on concepts learned in previous ones. This is fourth in the series and is designed around the conjunctive forms “only in”, “and in” and “but not in”. One frame and the accompanying questions, from near the end of the filmstrip, are shown below. The filmstrips were shown to groups of three or four, and the questions were asked verbally. The children were



4. Teaching conjunctive skills through filmstrips: Which dot or dots are in the square and the circle but not in the triangle? Which dot is in the triangle but not in the circle or square? Which dot is in the square and triangle but not in the circle?

required to respond verbally or, in certain circumstances, by raising colored blocks.

Results of Intervention Program

Upon completion of the intervention program, the groups were again given the baseline tests. The post-test results were compared by computing analyses of variance and covariance. The results from the analyses of covariance, showing the improvement of the experimental subjects, are displayed in Table 2. The results of the analyses of variance, showing absolute gains, are not presented here, but in general the experimental subjects showed greater improvement both in magnitude and in the number of significant improvements than the control subjects. As can be seen, there was no differential improvement on the WISC scores, but all measures of serial and free recall improved significantly. Surprisingly, although reading training was not specifically included in the program, the Schonell performance improved significantly. This was attributed to an improvement in word attack skills, which is dependent upon the serial strategies which were involved in remediation. Improvement in Progressive Matrices is not observable directly as percentile scores are confounded with age, but it was noticed that now more than two-thirds of the scores were above the fiftieth percentile. This could be attributed to the attention visual designs received in the remedial tasks. On the basis of these results, it was concluded that the remediation was successful in improving the performance of these children, particularly in those tasks which involve successive integration.

Das (1973b) has shown that three factors labeled Successive, Simultaneous and Speed emerge consistently in factor analyses using these same test measures. For this reason, although the sample was recognized to

TABLE 2
ANALYSIS OF VARIANCE WITH COVARIANCE ADJUSTMENT (PRE-POST)
BETWEEN GROUPS I and II

Test	F-ratio	p
WISC Verbal	0.00	NS
Performance	0.39	NS
Full Scale	0.00	NS
Progressive Matrices	0.09	NS
Schonell	11.74*	.002
VSTM Serial Position Recall	6.00*	.020
Free Recall	6.20*	.018
Cross-modal Coding	2.69	NS
Figure Copying	3.14	.085
Serial Learning		
Serial Position Recall	15.83*	.001
Free Recall	21.12*	.001

* significant improvement in performance

NS = nonsignificant

be small, a factor analysis on the pre- and post-intervention scores was performed. The results can be seen in Tables 3 and 4.

TABLE 3
ROTATED FACTORS (VARIMAX) FOR 10 COGNITIVE TESTS BEFORE
INTERVENTION: CANADIAN NATIVE CHILDREN (N=40)

Variable	I Successive	II Speed	III Simultaneous
WISC Verbal	479	639	-029
Performance	431	574	235
Progressive Matrices	678	-047	458
Figure Copying	330	-165	743
Memory for Designs	074	-287	-801
Stroop Word Reading	-056	-717	112
Visual STM	065	707	435
Cross-modal Coding	584	037	162
Serial Recall	840	287	-066
Free Recall	787	352	000
% Variance	26.62	20.71	16.92

Note: Decimals of factor loadings omitted

For factor I, the two highest loadings were for serial and free recall. These indicate a successive processing factor. Factor II had Stroop Word reading speed as the highest loading and was termed the Speed or “Personal Tempo” factor. In factor III, the high loadings were for the Memory for Designs and Figure Copying tests; it was termed the Simultaneous factor.

Factor I, besides the serial and free recall, also included Cross-modal Coding and Progressive Matrices. The CMC, although sometimes considered a speed task (Das, 1973b), clearly has a serial element also and the results here indicate it was processed in much the same manner as other auditory stimuli (words).

Factor II includes not only the Stroop Word reading speed, but also VSTM and, to a lower degree, the WISC Verbal and Performance scores. Visual Short-term Memory certainly could have a speed component, and it seems that the variation in performance was determined by the ability to process information rapidly. Speed is perhaps a critical factor in short-term memory, as the memory trace may disappear before the correct response is recognized. This may be true also for the WISC items. Perhaps the Hobbema children “take their time” in verbal tasks and thus performance in these tasks is determined by speed rather than simultaneous or successive factors.

Factor III has its highest loading of FCT and MFD. These are both highly spatial tasks. The intermediate loadings of Progressive Matrices and VSTM suggest these tasks are processed only partially by a simultaneous strategy.

In the factor analysis based on post-intervention scores, the factors

TABLE 4
 ROTATED FACTORS (VARIMAX) FOR 10 COGNITIVE TESTS FOLLOWING
 INTERVENTION: CANADIAN NATIVE CHILDREN (N=40)

Variable	I Successive	II Simultaneous	III Speed
WISC Verbal	347	364	665
Performance	515	391	547
Progressive Matrices	253	544	276
Figure Copying	-034	848	-227
Memory for Designs	-232	-720	-110
Stroop Word Reading	036	136	-833
Visual STM	401	499	303
Cross-modal Coding	749	-062	252
Serial Recall	881	317	026
Free Recall	892	293	022
% Variance	27.98	22.77	17.32

Note: Decimals of factor loadings omitted

emerged in a different order. The serial factor continued to account for the most variation, but now the speed factor became less important than the simultaneous in accounting for the variance. In addition, the total commonality increased from 68 to 74 per cent, thus indicating more reliability. It seems probable that the remediation treatment reduced the gap between potential and performance for some children.

The following important shifts in the factor loadings were noticed. The Progressive Matrices now loads most highly on the simultaneous factor. This seems to be in greater accord with the nature of the test. It should be noted that this was accompanied by an improvement in the total scores on Progressive Matrices.

The VSTM now loads more appropriately on the serial and simultaneous factors rather than on speed and simultaneous. It seems that the introduction of consistent search and recall strategies has eliminated speed as a limiting variable. Again, the shift was accompanied by an improvement in performance in visual short-term memory.

On the other hand, although scores for the serial and free recall tests showed highly significant improvement, the factor loadings did not shift. This also is expected; these have been found to be the marker tests for the successive factor.

The results of the factor analyses on post-intervention scores thus support the emergence of simultaneous, successive and speed factors, describing the performance of subjects in the present test battery. The effect of intervention was to increase the reliability of the subjects' performance, so that the factor structure is comparable to that obtained in previous studies on Caucasian school children.

The covariance analysis has shown that two main areas of cognition improved: visual and auditory short-term memory. It was felt that the main

agent of improvement was the concentration on sequential strategies in the remediation program.

The children participating in this study proved to have well-developed simultaneous strategies, but these were often used in place of the more efficient sequential processes, particularly in tasks requiring visual search and ordering. It was clear from observing the performance of children that order was not important. However, most academic tasks demand specific sequential operations and this seems to be the area of difficulty for Indian children.

This study served to demonstrate that when appropriate remedial programs are used, cognitive strategies can be taught. However, it remains to be demonstrated how long the new strategies last and how far these will be carried over to the academic tasks.

Results of the factor analyses reinforced the impression that the new strategies were more appropriate, as the shifts in the factor loadings following intervention were accompanied by significant improvements in task performance requiring successive processing.

Generally, the intervention tasks were based on easily obtainable materials and were not complicated. The main innovations were in the ways materials were used. We suggest that any intervention program need not be content-specific, but it should have a sound theoretical structure. This has the obvious advantage of being easily incorporated into a teaching structure.

As a footnote, one could add that intervention programs have come under some criticism in recent years (Cole & Bruner, 1971; Baratz & Baratz, 1970). The main objection has been that intervention programs accept the "deficit" hypothesis rather than the "difference" hypothesis in the relationships of cultures to one another. The deficit is seen only when the group is compared to idealized American norms of behavior (Baratz & Baratz, 1970). This would certainly be true if the groups did not interact or compete with each other. However, if the child is expected to develop his full potential in the context of the major society, he must acquire the skills to do so (Das, 1973a). Poor or inefficient strategies, whatever their source, must be corrected in order that this end be achieved.

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¹ All tests except the WISC and Schonell have been described previously (Das, 1972b). They have been classified as representing the three factors of simultaneous and successive information integration, and the speed of integration.

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P. F. W. PREECE

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Science Concepts in Semantic Space— A Multidimensional Scaling Study

The present study, using 100 subjects, was a cross-sectional investigation of the development of semantic space for the domain of classical mechanics, covering the whole period in which physics is taught at school and university. Data on the semantic proximity of mechanics concepts, obtained by means of a continued word association test, were analysed by individual difference multidimensional scaling, which permitted the mapping of semantic space for individual subjects. Substantial retest stability of group average semantic structures was found, although individual differences in semantic structure were somewhat unstable. (Dr. Preece is Lecturer in Education at the University of Exeter.)

In a discussion of the development of word meaning, Evanechko, Armstrong, and McFetridge (1974) have argued that the semantic organization underlying an individual's verbal behavior might comprise a Euclidean multidimensional semantic space in which the dimensions, representing the ways in which word meanings could vary, might be identified with orienting reactions acquired by the individual. The technique of multidimensional scaling (MDS) immediately suggests itself as an aid to operationalizing this model, and in the present investigation this instrument was used in an attempt to construct individual semantic spaces in one semantic domain. The domain chosen was classical mechanics, both because of its central importance in learning science and because mechanics concepts have been the subject of some earlier work on semantic space.

The object of MDS is to represent the structure in matrices of proximity data—in this case, interconcept proximities—in a spatial model of as few dimensions as possible, the interconcept distances in semantic space being related, linearly in metric MDS or monotonically in nonmetric versions, to the original interconcept proximities. Johnson, Cox, and Curran (1970), in a pioneering application of MDS to the semantic relations among six mechanics concepts, used two methods for obtaining proximity data. Fifty college physics students provided similarity ratings for all possible concept

pairs and also gave one minute of continued word associations to each concept word. The mean rating judgment and the mean proportion of associations common to each pair of concept words provided proximity measures for Kruskal's (1964) MDS procedure. Similar configurations of concepts in three-dimensional semantic space were obtained for the two sets of proximity data, and the configurations were shown to be closely related to a logical model of the conceptual structure. This study was severely limited, however, because it only yielded a group average semantic space and did not take into account individual differences.

In order to investigate individual differences, Kass (1971) used a method developed by Tucker and Messick (1963) to identify individual viewpoints in MDS. In this study, the proximity data were obtained from 353 grade 12 physics students who rated all paired combinations of 20 mechanics concepts for differences in difficulty. All subjects, however, seemed to construe the conceptual relations in essentially the same way and the investigation was only able to yield a group average space. Four or five dimensions were required for a fair fit (Kruskal, 1964), the first dimension separating dynamics from statics concepts and the second dimension separating vector and scalar quantities. The remaining dimensions were not clearly defined, but a *force-work-power* cluster appeared on one remaining dimension.

Shavelson (1972) attempted to trace the effects of learning mechanics on semantic space by giving 28 high school students a continued word association test, with 14 mechanics concept words as stimuli, as a pretest and after each of five consecutive days of instruction. A measure of the overlap between the individual response hierarchies to two concept words provided an index of proximity, and median proximities were calculated for each concept pair and subjected to Kruskal's MDS procedure. Two-dimensional solutions were found to match the data quite well, but they did not reveal any effects of instruction. Four main concept clusters emerged in each solution (and in the solutions for a control group of 12 students). Cluster 1 included the concepts *force*, *work*, *power*, and *energy*; cluster 2 included *mass* and *weight*; cluster 3 included *distance* and *time*; and cluster 4 included *velocity*, *speed*, and *acceleration*.

The present investigation attempted to provide some information on two problems raised by the work noted above. Firstly, it attempted to measure individual differences in semantic space and their stability; and secondly, it attempted to trace changes in semantic space during the period in which physics is learned. Carroll and Chang's (1970) procedure for individual differences multidimensional scaling (INDSCAL) was used to tackle the first aim, and a cross-sectional approach covering the whole period during which physics is studied at school and university was used to tackle the second aim.

Method

Subjects

As one aim of the investigation was to trace developments in semantic space for those learning physics, throughout the period of instruction from school to university, and as university physics students are mostly male and from selective academic secondary schools (grammar schools), the school

subjects were chosen from a boys' grammar school. Groups of 20 students studying physics in the first form, fourth form, and seventh form were tested. The mean ages of the students in each group were 12 years 3 months for the first-form group (A), 15 years 4 months for the fourth-form group (B), and 18 years 2 months for the seventh-form group (C). In addition, two groups of university graduates were tested. The science graduate group (D) consisted of 15 men and 5 women, mean age 23 years 6 months, taking courses for prospective physics teachers at two universities. The nonscience graduate group (E) consisted of 10 men and 10 women, mean age 23 years 0 months, also taking a university course for prospective teachers.

Procedure

The word association method of obtaining proximity data was used. All subjects took a word association test which required one minute of continued associations to each of the 15 mechanics concept words shown in Table 1. Details of the test and of the procedure have been given elsewhere (Preece, 1976a). In order to investigate the stability of configurations in semantic space, Groups A, B, and C were retested after an interval of a few weeks, the interval coinciding with vacations so that no instruction took place between tests.

TABLE 1
THE FIFTEEN MECHANICS CONCEPTS

Concept	Symbol	Concept	Symbol
Distance	L	Acceleration	a
Area	A	Force	F
Volume	V	Weight	G
Mass	m	Pressure	P
Density	d	Work	W
Time	t	Energy	E
Speed	u	Power	P
Velocity	v		

Results

A half-matrix of overlap coefficients, giving the overlap between every pair of response hierarchies, was calculated for each subject. Garskof and Houston's (1963) relatedness coefficient was used as a measure of overlap, with the parameter, p , given the value 1, which yielded a coefficient in which greater weight was given to earlier responses. These overlap coefficients were taken as individual measures of concept proximity and used as the input in separate INDSCAL analyses for each group.

The INDSCAL solution consists of a group space in which the concepts are located (a compromise based on the data for all subjects) and a subject space of the same number of dimensions in which each subject is represented by a point which gives the weight which each subject attaches to each dimension (i.e., subjects differentially expand or contract the group configuration in the direction of the axes). Solutions were obtained in four,

three, two, and one dimensions, although the following discussion is mostly confined to the two-dimensional solutions, which were readily interpretable and which were shown, in a number of trial runs, to be largely independent of the initial concept configuration adopted as the starting point for the iterative analysis.

Figure 1 shows the two-dimensional concept space for Group D (science graduates), the group most knowledgeable in physics. The concept space for Group C (seventh-form physics students who had studied mechanics in depth) was closely similar, providing some confirmation of this as the concept configuration in the semantic space of subjects knowledgeable in mechanics. For these two groups, dimension 1 separated the kinematics concepts *acceleration*, *velocity*, *speed*, *distance*, and *time* from the statics concepts *weight*, *mass*, *volume*, *density*, *area*, and *pressure*. The concepts *work*, *energy*, and *power* were placed between these polar clusters on dimension 1 and separated from them on dimension 2. It is a feature of INDSCAL solutions that the dimensions are always arranged in an order reflecting the amount of variance in the empirical matrices accounted for, with dimension 1 accounting for most variance, dimension 2 making the next largest contribution, etc. Thus the existence of this division between statics and kinematics concepts on dimension 1 showed that this distinction was the most important one made by these subjects. Finally, for Groups C and D, the concept *force* occupied an intermediate, central, position between the energy and statics clusters.

FIGURE 1
TWO-DIMENSIONAL CONCEPT SPACE FOR GROUP D

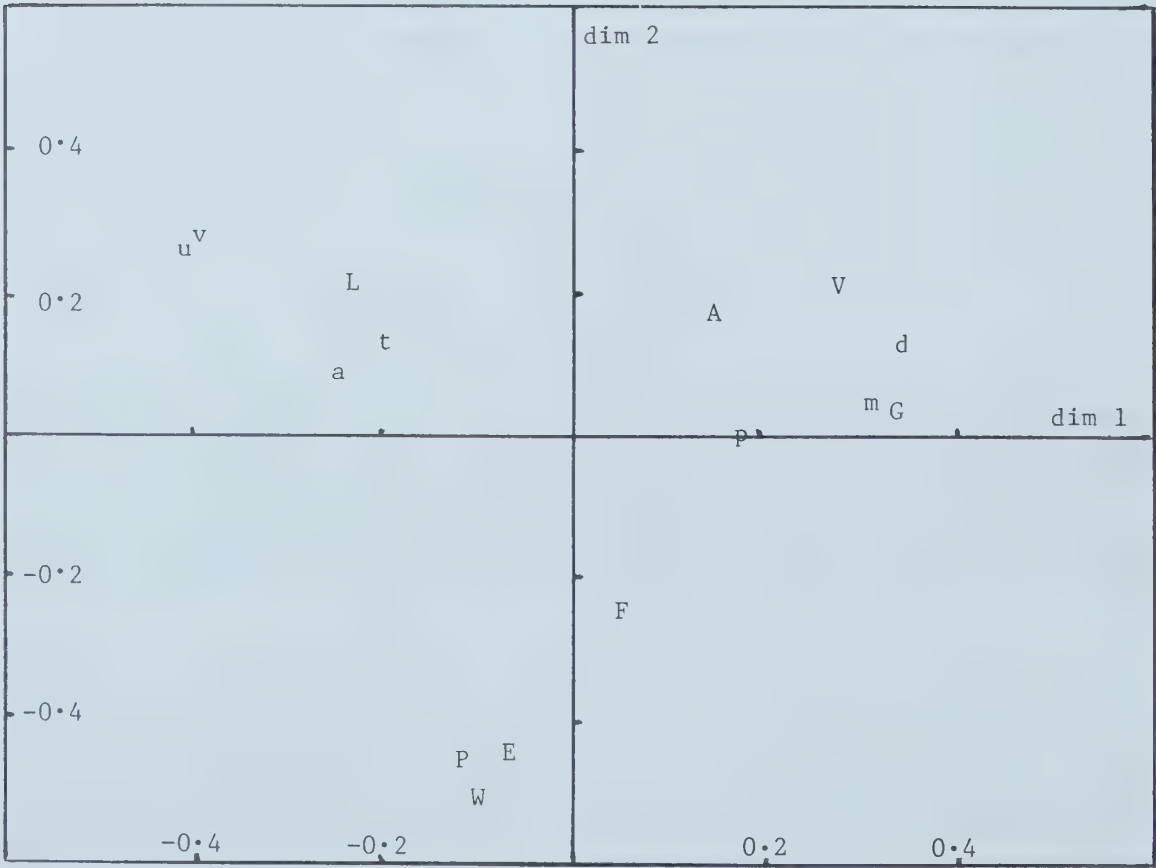
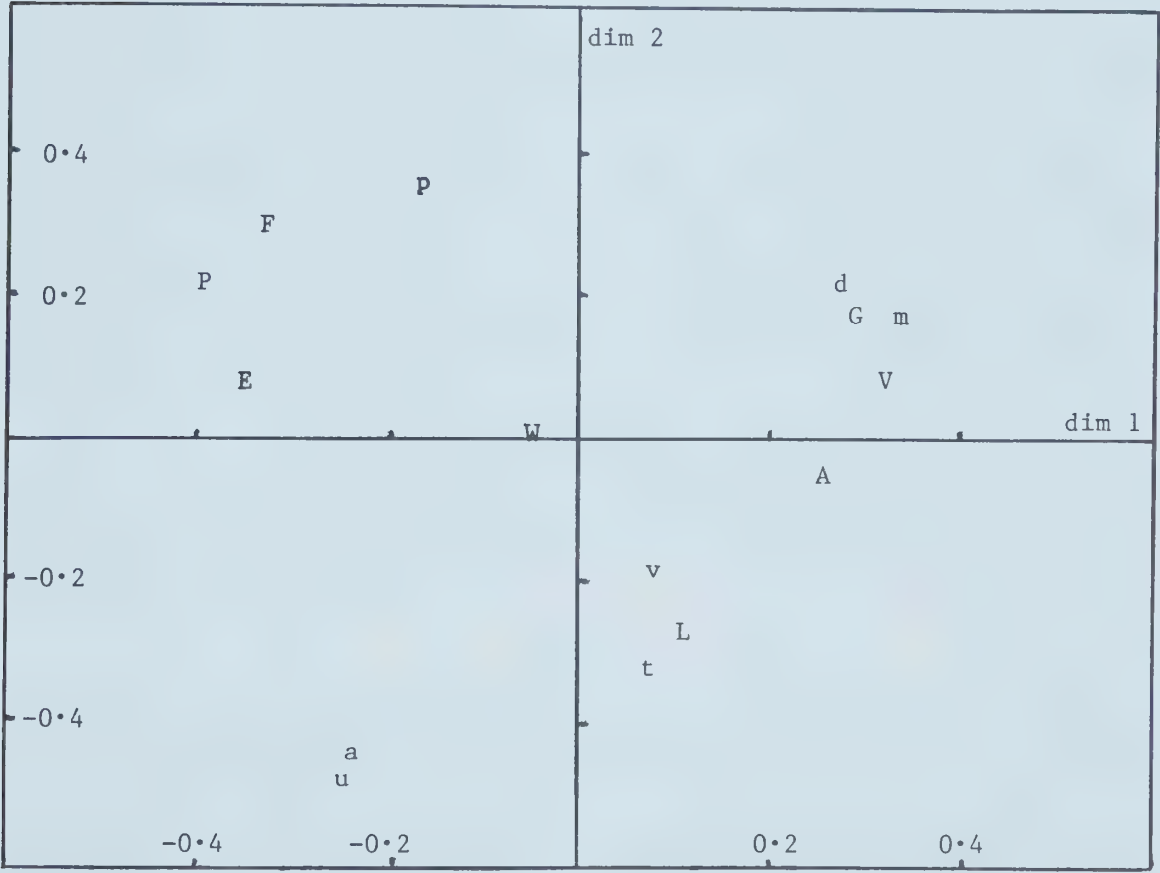


Figure 2 shows the two-dimensional concept space for Group A (first-form students) which was similar to that of Group E (nonscience graduates). For these groups, which contained the subjects with the least knowledge of mechanics, the concepts were less clearly clustered than for the other groups, although the same three groupings could be discerned. In both cases, the concept *work* was close to the origin and separated from the other concepts. In the two-dimensional concept space for Group B (fourth-form students), the concept *work* had entered the energy cluster, but the concept *force* was also in the energy cluster, as in Groups A and E, and it had not taken up the central position it had for Groups C and D. Thus Group B occupied an intermediate position between Groups A and C.

FIGURE 2
TWO-DIMENSIONAL CONCEPT SPACE FOR GROUP A



For the three groups retested (A, B, and C), the test and retest concept spaces were closely similar, demonstrating the stabilities of the group semantic structures. This stability was simply quantified by calculating the test-retest correlations of the concept coordinates on each dimension of the two-dimensional group space. These stability coefficients for each group are given in Table 2.

This stability was not evident, however, on inspecting the subject weight spaces for the test and retest for these groups. Now, because of the way in which the subject space is normalised, the square of the distance of a subject point from the origin is roughly interpretable as the proportion of variance in that subject's data which is accounted for in the solution. Thus a point

TABLE 2
STABILITY COEFFICIENTS FOR TWO-DIMENSIONAL GROUP CONCEPT SPACE

	Dimension 1	Dimension 2
Group A	0.87	0.83
Group B	0.98	0.98
Group C	0.94	0.92

coinciding with the origin of the subject weight space would indicate that the group configuration accounted for none of that subject's data. Conversely, a point located one unit distance from the origin would indicate that the group configuration (suitably adjusted by the weights attached to each dimension by that subject) accounted for all the subject's data. Thus the stability of a configuration in subject weight space can be simply indicated by the reliability of an index of conformity, giving the correlation between the solution and the original data, which is computed for each subject in the INDSCAL program. The test-retest reliabilities of this conformity index for the solutions in four, three, two, and one dimensions, for the three groups retested, are given in Table 3. The values of these reliability coefficients indicated some, but not substantial, stability of individual differences in the configuration of concepts in semantic space.

TABLE 3
RELIABILITIES OF CONFORMITY INDEX

	4D	3D	2D	1D
Group A	0.41	0.37	0.52	0.36
Group B	0.09	0.17	0.23	0.71
Group C	0.52	0.56	0.41	0.25

The INDSCAL program also yields an overall correlation between each solution and the original data. To achieve a correlation of about 0.70, four dimensions were required for Group A, three dimensions for Group E, and two dimensions for Groups B, C, and D. This suggested that the subjects' semantic structures were less idiosyncratic, permitting more parsimonious solutions, in these latter groups.

Discussion

Considerable stability of group semantic structures was demonstrated, although individual differences in structure were somewhat unstable. This is, perhaps, to be expected considering the homogeneity of the groups, although the apparent instability of individual differences could reflect the unreliability of the measuring instrument. There are a number of techniques for measuring semantic proximity and there is a good deal of evidence of

their convergent validity as tools for mapping group semantic structure (Preece, 1976b). It would now be valuable to compare their efficacy in the exploration of individual semantic space. It should be noted, however, that alternatives to the spatial representation of semantic structures exist. Thus Preece (1976a) has suggested that a hierarchical network structure may be particularly appropriate in the domain of classical mechanics.

Although the group concept spaces of all the groups in the present investigation were dominated by three concept groupings—the kinematics, statics, and energy clusters—there was clear evidence of semantic development on going from the least to the most knowledgeable groups. For the least knowledgeable groups (A and E), the clusters were less tightly organized and the concept *work* had not entered the energy cluster, perhaps reflecting the dominance of the everyday meaning of that word for those groups. For the intermediate group (B), the concept *work* had entered the energy cluster, but it was not until the most knowledgeable groups (C and D) that the concept *force* had left the energy cluster to take up a position reflecting its central role in mechanics.

The importance for studies of progress in learning of tracing the development of semantic structures in this way and of elucidating the differences between the structures of experts and neophytes has been discussed by Michon (1972), and Fenker (1975) has provided direct evidence that students whose “cognitive maps” match those of experts achieve better course grades than students without appropriate maps. Moreover, Fenker noted that mapping the semantic structures of individual students is necessary in studying meaningful learning, which is characterized by the incorporation of new material into existing cognitive structures (Ausubel, 1963). Indeed, it is the key role of an individual’s cognitive structure in the learning process, so forcefully stressed by Ausubel, that makes the development of reliable techniques for mapping the semantic space of individuals so important.

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Problems of Control in Nonexperimental Educational Research

The use of analysis of covariance and other techniques to control nuisance variables in educational research is a common strategy. In the present paper, an attempt is made to show that these procedures may introduce more problems than they solve. It is suggested that describing the situation as it exists in its complexity may be preferable to trying to control nuisance variables statistically. (Dr. Maguire is with the Division of Educational Research Services, Faculty of Education, The University of Alberta; Dr. Haig is with the Department of Education, Canterbury University)

Each year throughout North America, graduate students in education are exposed to the mysteries of the design and analysis of educational experiments. Using the now classic treatise of Campbell and Stanley (1963), they learn that many of the sources of invalidity that cloud the investigation of relationships among educational variables can be controlled through the use of "True Experiments." They learn that, in the basic true experiment, subjects are randomly assigned to groups, the groups are treated differentially, and observations are made to determine the effects of the treatment. The magic potion that controls the "nuisance" variables is random assignment.

In spite of the validity of the claims made for the use of true experiments in educational research, by far the bulk of educational research is not truly experimental. Campbell and Stanley's pre- and quasi-experiments, the ex post facto experiments of Chapin (1955), case, correlational, and field studies, and clinical methods are common (but not mutually exclusive) examples of not truly experimental (NTE) research methods.

There are many reasons why NTE research flourishes. Often people cannot be randomly assigned to groups for ethical reasons, as for example in looking at differences in visual acuity between deaf and hearing children.

There may be administrative reasons that make random assignment impossible, as in a study of differences in teaching styles for teachers in rural and urban schools. Sometimes random assignment is impossible because the independent variable simply cannot be placed under the control of the research, as in a study of the effects of an economic recession on the quality of decisions made by school boards. Indeed, it is often true that the random assignment of subjects to groups produces such an artificial situation that it possesses no ecological validity in the Bracht and Glass (1969) sense. Occasionally, NTE research occurs as a result of poor planning or ineptitude on the part of the researcher. Regardless of the reasons for its use, one of the inevitable problems of NTE research is the confounding of nuisance variables with other variables.

Nuisance variables are variables that interfere with the relationships among the principal variables under study. In the simplest case they inject alternate possibilities for causal statements relating independent and dependent variables. Campbell and Stanley's sources of internal invalidity are examples of nuisance variables, in that they provide alternate explanations for differences that are observed. Other variables are identified as nuisance variables only within the context of a particular experiment. For example, Anderson (1971), in a study to determine the effects of course content and teacher sex on classroom climate, treated class size, girl/boy ratio, and class mean IQ as nuisance variables. Wessman (1972) treated IQ, age, and race as nuisance variables in a study of the effectiveness of a compensatory education program. Aiken (1972) described several studies relating language factors to learning in mathematics. Among the nuisance variables that occurred were initial mathematics ability, IQ, and computational ability.

That the confounding of nuisance variables in the relationship between independent and dependent variables is regarded as an important problem in educational research is well documented by the advice provided by reviewers and integrators of research in various areas. St. John (1970), for example, stated, "If school quality and family background are positively related to the achievement of minority pupils and to their schools' racial composition, it is crucial to control them in any study of the influence of ethnic composition (and school performance)" (p. 113). Welch (1969), after looking at several evaluation designs for mathematics curriculum studies and finding a preponderance of uncontrolled studies, suggested that analysis of covariance is one of the many techniques that curriculum evaluators can use to improve their investigations. Kerlinger (1967) too, noted that "The necessity of controlling extraneous independent variables is particularly urgent in field experiments . . ." (p. 383).

There are three procedures that have been prescribed for problems of confounded nuisance variables in NTE research: matching, partial correlation, and analysis of covariance. Basically, they all attempt to answer the same question: if the nuisance variables were controlled, what would be the relationship between the independent and dependent variables?

Meehl (1970) suggested that the solutions proposed for controlling nuisance variables might be worse than the problem itself. As an example, he described a hypothetical study in which the incomes of high school

graduates and dropouts are compared. If the graduates have higher incomes, it could be argued that this results from differences in IQ. To overcome this, graduates could be matched pairwise on the basis of IQ, and if a difference still exists in income, it might be said that the difference is not attributable to IQ. However, if we look carefully at a dropout matched with a graduate at IQ 125, we would have to admit that they are qualitatively different kinds of people. A dropout at that level likely has a lower conventional achievement need than the graduate. Considering the match at IQ 90, we would surely admit that the graduate has a very high achievement need. Meehl suggests that what we have done by matching an IQ is to make the groups unmatched on achievement need.

Although matching is used in the example, the consequences are no different when either partial correlation or analysis of covariance is used. In the present paper, the aim of the authors is to discourage researchers from using such techniques to eliminate nuisance variables. When the techniques are used in NTE research, they should be used with the intention of explicating the complex relationships that exist.

Some Consequences of Controlling Nuisance Variables

In educational research, the most common method of eliminating nuisance variables is through the use of analysis of covariance. Bay and Hakstian (1972) have shown that in the case of two treatments, the significant test for the analysis of covariance is algebraically equivalent to the significance test for the partial point biserial, i.e., the correlation between the treatment (expressed as a dichotomous variable) and dependent variable with the control variable partialled out. With this in mind, it is easiest to look at the problem from the simple vantage point of partial correlations, knowing that the comments apply equally to other correction methods.

Some of the areas to be considered have been discussed by Elashoff (1969) and by Evans and Anastasio (1968). Problems associated with unreliability of measurement and violations of assumptions have been set out by Lord (1963) and Glass, Peckham and Saunders (1972) and will not be reiterated here.

It is the central point of this paper that when attempts are made to partial out the effects of nuisance variables for the purpose of obtaining a clearer picture of the causal relationship between two variables of interest, the result is to change the nomological network in which the two variables lie. In short, one changes the constructs themselves.

To understand what happens when we partial the effects of a variable out of the relationship between two other variables, we must recall that the partial correlation is merely the correlation between two residuals. Suppose that X_1 and X_2 are two variables of interest. X_3 is a nuisance variable. Using simple regression techniques, we could predict X_1 and X_2 from X_3 as follows:

$$\begin{aligned}\hat{X}_1 &= b_{13} X_3 + a \\ \hat{X}_2 &= b_{23} X_3 + c\end{aligned}$$

If $e_1 = X_1 - \hat{X}_1$ and $e_2 = X_2 - \hat{X}_2$, then the correlation between e_1 and e_2 is the partial correlation $r_{12.3}$.

A second kind of correlation that is of interest is the part correlation. If we had a variable X_4 and correlated it with e_1 , then the result would be a part correlation, i.e., the correlation between variable 4 and that part of variable 1 which is uncorrelated with variable 3. The expression for a part correlation is shown below.

$$r_{(1.3)4} = \frac{r_{14} - r_{13}r_{34}}{\sqrt{1 - r_{13}^2}}$$

It is Meehl's argument that when you calculate the partial correlation between two variables of interest, you tend to make $r_{(1.3)4}$ greater than r_{14} , that is, you tend to *increase* the relationship between the independent variable and some outside variable. It is the contention of the present authors that this is the undesirable manifestation of the more general circumstance, that you have in effect changed the definition of the independent variable.

If we consider the formula for the part correlation, we can see how this happens:

Variable 1 is one of the variables of interest (perhaps the independent variable). Variable 2 is the other variable of interest.

Variable 3 is the nuisance or *control* variable that is identified by the investigator for control.

Variable 4 is an outside variable that is not considered in the experiment.

Most often r_{13} is a reasonably large correlation, since it is a nuisance variable of sufficient degree to have attracted attention. The expression $\sqrt{1 - r_{13}^2}$ will be less than one, and the larger r_{13} is, the smaller $\sqrt{1 - r_{13}^2}$ will be. Thus the denominator of the expression for the part correlation will have the effect of "magnifying" the numerator.

It might be argued that any outside variable that is correlated as much as .4 with the independent variable would itself be identified as a nuisance variable, and steps could be taken to control for it. On the other hand, if the correlation between the outside variable and the control variable is near zero, and the correlation between the independent variable and the outside variable is near zero, then there is no problem, because the numerator of the expression is zero, and no amount of magnification by $\sqrt{1 - r_{13}^2}$ can change that.

The more serious problem arises when r_{14} is very near zero, and r_{34} is magnified by

$$\frac{r_{13}}{\sqrt{1 - r_{13}^2}}$$

When r_{14} is near zero, it will almost surely be overlooked in the theory that binds variables 1, 2 and 3. However, if r_{34} is very large, then variable 4 will be dragged to our attention on the coattails of variable 3. The area in question occurs when r_{14} lies in the interval from -.2 to +.2, and r_{34} is fairly small, say less than .4 in absolute value.

A recent article by Barik and Swain (1976) provides an example of a situation in which the problem could arise. As a part of a larger study, a group of Grade 1 students participated in a French immersion program for two years (kindergarten and grade 1). Their achievement after two years

was compared with that of a similar group of children who were comparable on age and socioeconomic background. Among the several achievement variables measured was the arithmetic subtest of the Metropolitan Achievement Tests. At the end of grade one, the mean arithmetic score for the immersion group was significantly higher than that of the control group. It was noted that the groups showed significant differences on Deviation IQ(DIQ) as measured by the Otis-Lennon. Both measures were taken at the end of grade 1. The authors used DIQ and age as covariates and found that there were no significant differences between the adjusted arithmetic means. The thrust of the conclusion was that the immersion program did not appear to produce any deficit in arithmetic. Although the present authors would question the use of the DIQ measured at the end of grade as a covariate (since it could partial out differences that are legitimate treatment differences), we have no quarrel with the conclusions of the study.

If we assume that the inclusion of age in the analysis of covariance is of little consequence, it is possible to deduce the following correlation matrix from the results included in the Barik and Swain article. This assumption is plausible since the average ages of the curriculum groups are almost identical, and the narrow range of age usually encountered in the first grade is so small that the age-DIQ correlation will be very small.

	Curriculum	Arithmetic	DIQ
Curriculum	1.00		
Arithmetic	.345	1.00	
DIQ	.360	.527	1.00

The curriculum variable is made by assigning a score of 1 to all in the immersion program, and a 0 to those in the comparison group. The correlation between curriculum and achievement with DIQ partialled out is .20. Thus controlling for DIQ had the effect of reducing the correlation with achievement from .345 to .20.

To illustrate what could happen when the groups were equated on DIQ, we can append some *hypothetical* results to the Barik and Swain data. In many classrooms there is a small but negative correlation between the amount of attention that is given to a student and the achievement level of the student (see for example Macdonald, 1972). In addition, we could assume for the sake of argument that there is a small but negative correlation between DIQ and teacher attention, with the less intelligent students receiving slightly more teacher attention than their more intelligent classmates. If we suppose that in the Barik and Swain study, the teachers in the immersion group gave slightly more attention than those in the comparison group, then the following correlations may have resulted:

	Curriculum	Arithmetic	DIQ
Teacher Attention	.20	-.20	-.30

The correlation between teacher attention and curriculum with DIQ partialled out is .35. By partialing out the effect of DIQ, we have increased the correlation between teacher attention and curriculum from .2 to .35. This means that we have made the groups as different on the outside variable as they were on the covariate before the correction was made.

In a sense, we have redefined the "Curriculum" variable to become "Curriculum with DIQ partialled out", and statements of relationships which apply to the latter variable need not apply to the former. Consequently, efforts to clarify the role of "Curriculum" by controlling nuisance variables may have the effect of producing new nuisance variables. The frustrating aspect of this problem is that the researcher is almost never aware of what the new nuisance variables are.

Some Side Issues

In passing, one might ask if the use of analysis of covariance to improve power in a true experiment has the effect of producing a systematic difference in randomly equivalent groups. The answer is no—as can be seen in the two group case.

Let X be the treatment variable scored 1, 0, Y be the dependent variable, for example, achievement, Z be the covariate, IQ, and W be an outside variable such as motivation. Over the long run, the expected value of r_{xz} is zero because people are randomly assigned to groups, and the covariate is measured before the treatment. Thus,

$$r_{xy.z} = \frac{r_{xy}}{\sqrt{1 - r_{yz}^2}}$$

and so the power is increased. But what happens to the partial correlation $r_{xw.z}$? To begin with, because of the random assignment of people to groups, r_{xw} should be zero in the long run. That being the case, the partial correlation turns out to be

$$r_{xw.z} = \frac{0 - 0 \times r_{wz}}{1 \sqrt{1 - r_{wz}^2}} = 0$$

Consequently, in the true experimental case, there is no expected mismatch on the outside variable arising from the use of a control variable.

It is also of interest to see if the problems that arise in NTE designs and the use of analysis of covariance also arise in the use of analysis of variance in the NTE design. For example, suppose there is a two-curriculum study, in which groups are not randomly assigned to treatments. If we think that intelligence has a possible effect, we might try to control it by using it as a factor in a treatment-by-IQ analysis of variance. We can do this in two ways. In the first way, we might dichotomize (or use any number of levels) IQ by cutting below and above 110. If IQ is a reasonable cause for the observed difference in the dependent variable (at this rather gross level), then we will find that there are disproportionate numbers in the cells of the two-way design. If we analyse the data using least squares procedures for the unequal n ANOVA, then the problems described earlier will occur, since the analysis is no different in principle than using analysis of covariance with IQ levels and IQ by treatment interaction as covariates. And since IQ and treatment are correlated, the correlation could serve to increase the correlation between the "adjusted" treatment variable and some outside variable.

If on the other hand, after we make our groups on IQ, we randomly throw out subjects to make the cell sizes equal, then we make the correlation

between the independent variable and the nuisance variables zero. So that $r_{(1.3)4} = r_{14}$. The same situation holds true in any two-way design in which we have equal cell sizes, and subjects not assigned at random.

Of course in most two factor NTE designs, the factors are chosen because of the possible relationship to the dependent variable, and not because of their relationship to each other.

Discussion

In the past, design experts have often been able to supply pat remedies to problems that are raised. Complexity of numerical methods has usually outstripped advances in design methodology, and so new procedures could be prescribed to overcome the inadequacies of the old ones. In the present circumstances, however, the problems are not so easily solved. According to Cronbach and Meehl (1955) a construct derives its meaning from the network of relationships that connect it with other constructs and with observables. When we partial out or control the effects of nuisance variables, we change the nomological network in which the variables of interest are embedded. Or, put another way, the relationships among residual variables are simply not the same as the relationships among the original variables. We cannot interpret the residual variables as if they had the same construct status as the original variables.

As Meehl notes, when we try to investigate the relationship between naturally occurring characteristics by controlling for some nuisance variable, we are almost inevitably led to the assertion of a counterfactual conditional statement such as "If dropouts and graduates had the same average IQ, they would earn different salaries." Traditionally, researchers have acted as though the counterfactual premise (if dropouts and graduates had the same average IQ) could be true in isolation from all other variables. We have seen that this is not true. When we correct for IQ, we change the outside relationships. Additionally, Meehl argues that the implicit assumption does not make common sense. A society in which dropouts and graduates have the same average IQ may have such different sociological mechanisms operating that the dynamics underlying income, IQ and schooling would be radically different. For example, in the late fifties the difference in average IQ between college graduates and dropouts may have been larger than it was in the late sixties. Yet partialling out IQ in 1958 would not likely have given rise to images of the social environment of the sixties.

Perhaps the most useful way to deal with the problem of interpreting NTE research is to live with the nuisance variables and incorporate them into our models of behavior. By doing this, we construct models to fit the world, rather than constructing worlds to fit our models. In classroom research and evaluation, if naturally occurring characteristics confound each other, it does not make sense on either scientific or pragmatic grounds to try to isolate effects of individual variables. The nature of the domain in which we work is complex and interactive; our models and procedures must reflect this. Too often we have tried to overcome simplistic observation with complex analyses. It makes more sense to take more observations across time in an attempt to capture the interweaving of variables. At the present

stage of sophistication, reliable description of changing relationships will lead us further than touched-up cross-sectional snapshots.

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Effects of Data Classification on Mind Set of Grade Six Students

The study's purpose was to research the purported effects of reduction of "mind set" and achievement of greater consistency in data classification when using Simon's Problem-Solving Approach. The presence of "mind set" relating to the desirability, feasibility of further controlling water pollution in Canada was identified in a pretest administered to 248 grade six students in four schools. Within each school, four random groups were formed and a posttest, consisting of an article which pointed to the undesirability and infeasibility of further controlling water pollution, was administered. Group 1 read the article; group 2 classified the data with feasibility criteria specified. Group 3 was given desirability criteria also, and group 4 was trained in classification procedures. Trained subjects scored significantly more correct classifications than did untrained subjects ($p \leq .05$) and achieved more correct conclusions ($p \leq .05$) indicating that "mind set" could be partially reduced through the classification procedures. (Dr. Wright is Assistant Professor of Social Studies Education at the University of British Columbia; Dr. Simon is Professor in the Department of Curriculum and Instruction, Faculty of Education, The University of Calgary.)

As a result of the past decade of ferment in the Social Studies, teaching in this subject area has moved beyond the emphasis on facts and the transmission of the cultural heritage. The literature on the teaching of Social Studies now stresses student examination and evaluation of social problems. Consistent with this view, the Alberta Social Studies program (Department of Education, 1971) quotes Price: "We cannot teach children to engage in inquiry and discovery and have them refrain from pushing their questioning to the point of asking what ought to be" (p. 23).

In order to research "what ought to be" or "should" questions, a particular problem solving procedure seems necessary. Such a method has been developed by Simon (1970) and it is this "Reconstructive Approach"

which is recommended by the Alberta Social Studies Program (Department of Education, 1971, p. 12) for use in Alberta schools. This model has several unique features. The investigation relies on a hypothesis as to the desirability and feasibility of taking action on a policy making "should" question which is of immediate concern to students. Testing the hypothesis requires the use of a representative sample of data pertinent to the problem, and the classification of purported evidence into desirable (D) and undesirable (UD) as well as feasible (F) and infeasible (IF) categories. The "survival" goal (human and ecological survival and the physical and psychological well-being of individuals) is used as the criterion for classifying purported evidence into the D and UD categories. Criteria for classifying purported evidence into the F and IF categories include cost, legality, available time, past successes/failures, public and private attitudes, technology, existing relevant policies, and the availability of human resources, social processes and structures.

The actual sequence of the Simon model is as follows:

1. Identifying and clarifying a "should" question.
2. Formulating a hypothesis on the desirability and feasibility of taking action on the problem.
3. Collecting a representative sample of data.
4. Classifying the data into Desirable/Undesirable, and Feasible/Infeasible categories.
5. Analyzing the data.
6. Evaluating (testing) the hypothesis on the desirability and feasibility of taking action on the problem.
7. Proposing a course of action on the problem. (This may lead to overt group or individual action.)

The major question examined in this study, however, relates to a purported effect of using the classification scheme in the inquiry model. Simon (1970) states, "Systematic classification reduces the effects of the student's mind set . . . when he analyses his data" (p. 41).

A survey of the available related literature revealed that, although numerous techniques had been used by researchers to reduce "mind set," none had used any type of classification scheme. This study was therefore regarded to be both necessary and unique.

Principally, then, this study attempted to determine whether "mind set" could be reduced by the use of Simon's classification scheme. Specifically and in total, the study was designed to test the following hypothesis:

- H₁ That the use of the Simon classification procedure will reduce the effects of "mind set."
- H₂ That the use of the survival goal, as the criterion for classifying data into the D and UD categories will result in a significantly greater number of correct entries in these categories ($p \leq .05$).
- H₃ That training in the relevant classification skills will result in a significantly higher number of correct entries in the assigned categories ($p < .05$).
- H₄ That training in the relevant classification skills will result in a

significantly higher number of correct conclusions on the desirability and feasibility of action on the problem.

H₅ That among treatment groups there will be a significant difference on the conclusions reached on the desirability/undesirability and feasibility/infeasibility of action on the problem.

H₆ That the use of the classification procedure is feasible at the upper elementary school level.

The Research Design

Sample

The entire Grade 6 population ($n = 248$) from four schools considered to be representative of the elementary schools in Calgary Catholic School District No. 1 were utilized.

Identification of a "mind set"

A test was administered to identify the subject's attitude towards the desirability and feasibility of taking action to control water pollution in Canada. The relevant test item was "hidden" in the test by including questions on the desirability and feasibility of taking action on various other unrelated concerns. The test was expected to reveal whether a "mind set," viz., a "readiness of the individual to organize his perceptions and cognitions in a particular way" (Krech, Crutchfield & Bellachey, 1962, p. 67) was initially present and widespread throughout the sample.

The experiment itself was carried out twelve days later. This twelve-day period was deemed long enough to erode any possible contamination by the earlier test and short enough to prevent possible confounding by external events such as a major pollution disaster or the teaching of a unit on conservation or pollution. Neither of these events was seen to occur, however, during this period.

The experimental instrument

The instrument used in the experiment consisted of information taken from "Water Pollution and You" (Elliott, no date, p. 1) and "Environment News" (Alberta Department of the Environment, 1971, p. 9). Information was paraphrased to a grade 6 reading level as determined by readability formulas and by piloting of the instrument. This reading was then ascertained by a panel of judges to say that action to control water pollution in Canada was neither desirable nor feasible. Their decision was based on a close examination of each sentence in the instrument, and on an agreement on whether a sentence spoke for the desirability/undesirability, feasibility/infeasibility of action to control pollution, or whether a sentence was irrelevant. The judges consisted of five instructors and graduate students familiar with the use of the classification design.

The design

In the experimental situation, the subjects in each school were randomly assigned to one of four groups.

Group 1. This group received printed instructions to read the experimental instrument and to conclude on the weight of evidence as to whether or

not the evidence pointed to the desirability, undesirability, feasibility, or infeasibility of taking action on the problem.

Group 2. The group received the experimental instrument in the format below (see Figure 1) and it was explained in print how to classify the evidence. No criterion for classifying evidence in the D or UD categories was given. The subject made his own decision as to whether an item pointed to the desirability or undesirability of taking action on the problem. However, feasibility and infeasibility criteria were specified and the subject was asked to classify items in the F or IF categories according to the criteria of cost, legality, available time, past successes/failures, public and private attitudes, technology and the availability of human resources and social processes. For example, if purported evidence showed that industry could not afford pollution control, this demonstrated that it was infeasible to take action to control water pollution in Canada. This group then concluded on the desirability/undesirability and feasibility/ infeasibility of action on the problem.

FIGURE 1
CLASSIFICATION DESIGN FOR GROUP 2

Statements	D	UD	F	IF
1. From kindergarten on up, Canadians of today know that this country's water supply is being polluted.				
Statements 2 to 14.				

Groups 3 and 4. These groups carried out the tasks assigned to Group 2. In addition, however, they received a description of the survival goal (human and ecological survival and the physical and psychological well-being of individuals) and were asked to use this criterion for classifying sentences into the D and UD categories. For example, if purported evidence showed that water pollution damaged the environment or adversely affected the well-being of people, this was classified in the D category, as it demonstrated that it was desirable to take action to control water pollution in Canada. For each statement the subject classified in these two categories, he was also required to answer the question, "Would survival be helped or hindered?" Then the subject concluded as to whether each classified statement stated or implied that it was D or UD to take action on the problem (Fig. 2). The directions for classifying items in the F and IF categories were the same as those for Group 2. For each item the subject classified into either the F or IF categories, he was asked to *state* whether the item stated or implied that it was F or IF to take action on the problem.

Group 4 received a forty-five minute training program conducted by the researcher immediately prior to the administration of the test instrument. During this time, subjects were trained in the application of the Simon classification procedure, using other than the experimental material. The "survival goal" was introduced and evidence classified according to this criterion. Then the feasibility criteria were presented and applied to practice

FIGURE 2
CLASSIFICATION DESIGN FOR GROUPS 3 and 4

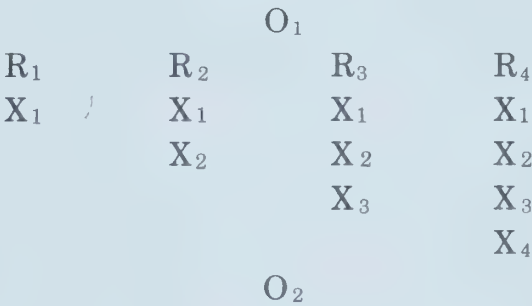
Should more action be taken to control water pollution in Canada?

Statements	D	UD	F	IF	Would survival be helped (1) or hindered (2)? Write 1 or 2 wherever a check mark appears in the D or UD column.	Is action D, UD, F or IF? Write D, UD, F, or IF.
Statements 1 to 14						

sentences. Finally, a practice exercise was given and Group 4 subjects classified each sentence into the D, UD, F, or IF categories, finally concluding on the weight or evidence as to the desirability/undesirability, feasibility/infeasibility of taking action on the stated problem.

Both the instrument to determine the presence of a “mind set” and the experimental test instrument were administered by classroom teachers who were instructed as to the procedures to be used.

Summary of the design



Where

- O₁ =observations from the instrument used to identify “mind set”
- O₂ =observations from the experimental instrument
- R₁-R₄ = treatment groups
- X₁ =reading the experimental instrument
- X₂ =classifying the evidence in the experimental instrument into D, UD, F, and IF categories with criteria assigned for classification in the F and IF categories only.
- X₃ =classifying the evidence in the experimental instrument, with a criterion specified for classification in the D and UD categories.
- X₄ =training in classification procedures.

Analysis of data

A chi-square test for independent samples was used to ascertain whether or not significant differences (*p* = .05) existed between the four groups on the desirability and feasibility or taking action to control water pollution in Canada. The same test was used to ascertain whether conclusions reached from the experimental instrument differed significantly from responses on

the instrument used to determine the existence of "mind set." In order to ascertain whether or not groups differed in the number of correct classification responses on the experimental instrument, a three-way ANOVA was performed, with an a posteriori Scheffé test applied in order to discover where possible differences might be.

Results

Hypothesis 1

This hypothesis stated that the use of the classification procedure would reduce the effects of "mind set." The hypothesis was supported in the D category ($p = .001$) for Group 4. Only here was there a statistically significant difference between responses to the "mind set" instrument and conclusions reached on the experimental test instrument. This indicated that "mind set" in this instance was reduced through training in, and use of, the classification procedures. Despite initial attitudes that it was desirable to take action to control water pollution, these Group 4 subjects correctly concluded that the experimental instrument pointed to the undesirability of such action. However, in the feasibility category for all groups and in the desirability category for groups 1, 2, and 3, it would appear that the existing attitude that it was desirable and feasible to control water pollution prevailed in the interpretation of the experimental instrument. These subjects apparently read into the data what they wanted to see, rather than what was actually there, demonstrating the existence of a "mind set".

Hypothesis 2

This hypothesis stated that the use of the survival goal, as the criterion for classifying items in the D and UD categories, would result in a significantly greater number of correct responses in these two categories. This hypothesis was not supported by the data. Group 4 subjects, who were trained in the use of the survival goal, did not differ significantly in the number of correct classification responses in the D or UD categories from Group 3 subjects who were not trained. Neither did untrained Group 3 subjects who used the survival goal differ significantly from Group 2 subjects who did not use the survival goal.

Hypothesis 3

This hypothesis stated that training in classification skills on the experimental instrument would result in a significantly higher number of correct classification responses reached. The hypothesis was supported by the data. Training (Group 4) resulted in a significantly higher number of correctly classified items, correct classification being determined by a panel of expert judges.

Hypothesis 4

This hypothesis stated that training in classification skills would result in a significantly higher number of correct conclusions on the desirability/undesirability and feasibility/infeasibility of action on the problem. This hypothesis was supported (Table 1). Trained (Group 4) subjects arrived at a higher proportion of correct conclusions (on the

TABLE 1
CHI-SQUARE PROBABILITY LEVELS ON DIFFERENCES BETWEEN GROUPS
IN CONCLUSIONS REACHED

Conclusions	Groups	2	3	4
Desirability	1	$p=.3 < p < .5$	$p=.5 < p < .7$	$p=.001$
	2		$p=.5 < p < .7$	$p=.02$
	3			$p=.01$
	1, 2, and 3			$p=.001$
Feasibility	1	$p=.95 < p < .99$	$p=.5 < p < .7$	$p=.05$
	2		$p=.5 < p < .7$	$p=.05 < p < .1$
	3			$p=.05$
	1, 2, and 3			$p=.01$

desirability/undesirability and feasibility/infeasibility of taking action on the problem) than did untrained Groups 2 and 3.

Hypothesis 5

This hypothesis stated that among the groups there would be a significant difference on conclusions on the experimental instrument relating to the desirability/undesirability and feasibility/infeasibility of action on the problem. As can be seen in Table 1, Group 4 differed significantly from each of the other groups in the D conclusions, and from the other groups, combined, in the F conclusions. However, Groups 1, 2, and 3 did not differ significantly from each other. This hypothesis was therefore not generally supported.

Hypothesis 6

This tested the feasibility of using the classification procedure at the upper elementary school level. The hypothesis was tentatively supported, as it was demonstrated that even with forty-five minutes of training, trained subjects could score relatively high percentages (64%) in correct classification responses.

Interpretation and discussion

Analysis of the classification responses and conclusions reached revealed that many subjects failed to relate classification responses to conclusions. For example, 75 subjects, regardless of group, classified the experimental instrument evidence predominantly in the undesirable category and, in keeping with the evidence, should have concluded that the article pointed to the undesirability of taking action on the problem. However, only 22 subjects concluded in this manner. Why this is so can only be conjectured. Was “mind set” operating so that the evidence pointing to the undesirability of taking action was overlooked? Perhaps, too, subjects had problems in classification. For example, a statement such as “. . . this country’s water supply is being polluted” has a negative undesirable message and yet, in relation to the problem, “Should more action be taken to control water

pollution in Canada?", this statement must be entered in the desirable category. This is so for the following reason: because the water is being polluted, it is desirable to take more action to control pollution. The frame of reference "shift" that is often required in order to classify data *in keeping with* the manner in which the problem is posed may have been a major difficulty, particularly for the untrained groups.

Conclusions

The findings of this study suggest that (1) "mind set" can be reduced by the use of the Simon classification procedure, (2) the use of the procedure is feasible in Grade 6, and (3) training in the relevant classification skills is necessary for the classification procedure to have significant effect on "mind set." Some questions pertaining to the classification procedure remain as yet unanswered, requiring further study. Suggestions for further study include:

1. Replication of this study at the same and different grade levels using different social issues.
2. Attempts to identify intellectual and affective factors that operate when students use the classification procedures.
3. Examination of the effects of extended training in the classification procedure.

This article is based on a M.Ed. thesis carried out in 1972 under the supervision of Dr. F. Simon at the University of Calgary. The first author is indebted to Dr. Simon, his thesis committee and the administrators and teachers in the Calgary Separate School Board who made the study possible.

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Educational Feasibility Studies: A Conceptual Framework

Administrators planning to adopt an educational innovation or change face high levels of risk which result from the attendant uncertainty of the innovation or change. A question often asked is, "Is it feasible to adopt this innovation?" Education feasibility studies offer a way of reducing the levels of uncertainty surrounding proposed innovations or changes, prior to adoption. An educational feasibility framework is described which considers constraints to feasibility, sources of data for determining feasibility, and feasibility study methodology. The framework may be translated into a study plan by specifying detailed criteria for assessing constraints, identifying data sources, and choosing an appropriate methodology. (Dr. Hathaway is an Education Consultant with the Planning and Research Branch of the Alberta Department of Education, Edmonton.)

As the pace of technological advancement quickens, ever-increasing numbers of changes and innovations confront the educational administrator. The risk of being innovative is high because many of these changes and innovations fail during adoption. There is need for a method of assessing or predicting the merit of a change or innovation before its adoption.

Prediction rather than description is the characteristic which most readily distinguishes feasibility studies from evaluations. Feasibility focuses on the "capability of being carried out or completed successfully, with predicted success significantly greater than chance" (Kaufman, 1972, p. 127). Evaluation, on the other hand, is described by Alkin (1969) as "the process of ascertaining the decision areas of concern, selecting appropriate information, and collecting and analyzing information in order to report summary data useful to decision-makers in selecting among alternatives" (p. 2).

Unquestionably, evaluations are necessary—they have a role to play in insuring that goals and objectives are attained. The point being made is that feasibility studies could be used more extensively to screen out methods of

attaining goals and objectives which would have a high probability of failure if adopted.

Feasibility is a multi-faceted concept. Hussain (1973) identified economic and financial constraints, organizational constraints, and technological constraints. Dror (1968) identified economic and political constraints. Johnson and Shearon (1970) suggested that feasibility is constrained by judgments of quality—effectiveness and efficiency. The concept of feasibility was further enlarged by the studies carried out at the University of Massachusetts (1970), to include a pedagogical constraint, a constraint of timeliness and an administrative constraint. Their administrative constraint appeared similar to Hussain's organizational constraint. Generalizability was identified as a constraint in the studies carried out by both the University of Massachusetts (1970) and Melnotte (1970).

Two sources of data for assessing feasibility have been identified. Johnson and Shearon (1970) discussed assessment of feasibility theoretically. Most of the other cited studies assessed feasibility operationally—through pilot studies or demonstrations.

Finally, two schools of thought were identified pertaining to feasibility study methodology. Kaufman (1972) prefers to continuously assess feasibility while nearly all of the other studies determined feasibility by means of a specific study conducted prior to complete adoption of an innovation. Johnson and Shearon (1970) identified four ways in which a specific feasibility study may be carried out: through consultation with experts, assessment, simulation, and demonstration.

Feasibility—Definitions and Models

In assessing the feasibility of an innovation, the first question which must be answered is, "What constitutes feasibility?"

Feasible, by definition, means "capable of being carried out." Clearly this definition differs from a definition of evaluation—"the process of assessing the attainment of objectives and the worth of programs" (Curtis, 1975, p. 51). Definitions of feasibility which are more specific than those offered by lexicographers are offered by relatively few educational theorists, mainly those who also advocate the use of various systems analysis techniques.

Hussain (1973) shed light on the meaning of feasibility. To one involved in operations research, a feasible solution is an optimum solution. To computer scientists, the feasibility study leads to a decision to acquire, or not to acquire, computer equipment. To the systems analyst, feasibility describes the practicability of a proposed change. It is in this latter sense that feasibility is used in this discussion. Hussain further enlarged the concept of feasibility by identifying and describing three types of constraints: economic and financial constraints, organizational constraints, and technological constraints.

The Georgia Study (Johnson & Shearon, 1970) considered feasibility criteria on two levels. The first-order feasibility criteria suggested that:

1. the program model should produce better teachers,
2. the developed strategy for developing and engineering the model should be effective in accomplishing its goals, and
3. the program model should be socio-psychologically feasible.

These first-order criteria were expanded to second-order criteria suggesting that:

1. the model should be reasonable in terms of demands on the time of students, teachers, and administrators,
2. the costs should be in line with present costs,
3. the instructional program should be acceptable to man's environment,
4. the needed materials and equipment should be attainable, and
5. the model program should be transportable to other institutions.

A study conducted at the University of Massachusetts (1970) to examine the feasibility of a Model Elementary Teacher Education Program attempted to answer six questions:

1. Is the model pedagogically sound—does it work?
2. Is the model economically feasible?
3. Is the model administratively feasible?
4. Is the model technically feasible?
5. Are the clients (those served by the model) satisfied?
6. Will the model retain relevance for teacher education? (University of Massachusetts, 1970)

The study method adopted by the University of Massachusetts was comprehensive. Pedagogical feasibility was determined by a study team for each subject area. Each of the other feasibility constraints was assessed across the entire program, with many of the feasibility assessment criteria selected on the basis of common sense.

Melnotte (1970) in his study into the operational feasibility of an apprenticeship work-study program raised a number of questions, some of which appear to be generalizable to a variety of feasibility studies.

1. How effective is the program in terms of the knowledge and skills gained?
2. How successful is the program?
3. How generalizable or exportable is the model or approach?
4. What is the student reaction to the program?
5. What should be the content and procedures for follow-up?
6. How responsive is the manpower pool?
7. What modifications of the model, or approach, might be considered for future efforts?

Timing of the Feasibility Study

When the feasibility study should occur in the planning cycle is yet another question of relevance. Kaufman (1972) suggested that feasibility can be determined as part of an ongoing study and Hussain (1973) outlined a discrete feasibility study plan. Most of the studies reviewed were of this latter type.

Constraints on Education Feasibility

The most important aspects of the educational feasibility study are the feasibility constraints. Eight feasibility constraints have been identified:

qualitative, organizational, technical, political, pedagogical, economic, timeliness, and generalizability.

Qualitative. The qualitative feasibility of a program or innovation is an expression of the effectiveness and efficiency of the program or innovation. Effectiveness is determined by the degree to which stated objectives are achieved. Efficiency describes the degree to which resources are used to produce a unit of output (or to achieve a stated objective).

Organizational. Organizational feasibility describes the impact the change may have on the organization. Hussain (1973) identified three areas of potential impact: the need for reorganization in order to implement the change; resistance to the change; and human resources which are inadequate by virtue of quality and/or quantity.

Technical. Technical feasibility describes the availability of the necessary hardware (things) and software (processes) required to implement an innovation.

Political. Assessing political feasibility constitutes determining that an innovation meets the needs of its clientele in a way that does not conflict with social values and norms.

The political feasibility of a policy is the probability that it will be sufficiently acceptable to the various secondary decision-makers, executors, interest groups, and publics whose participation or acquiescence is needed, that it can be translated into action. Political feasibility depends on the power structure of the involved systems, and on the ability of the policy-makers and of the policy itself to recruit support. (Dror, 1968, p. 35)

Pedagogical. Pedagogical feasibility describes the extent to which an innovation, or program, is educationally sound.

Economic. The economic constraint is composed of two components. First, the innovation is constrained by its cost-benefit or cost-utility ratio. Secondly, the innovation is assessed in terms of cost-fit (the extent to which the innovation can be financed from existing resources).

Timeliness. Timeliness assesses feasibility in terms of the relevancy of the approach both now and in the foreseeable future. Stated another way, a timely innovation should be able to interface with known and foreseeable constraints.

Generalizability. Assessment of generalizability focuses on the range of areas in which an innovation may be applicable.

A Conceptual Framework for Studying Educational Feasibility

Three facets of the educational feasibility study have been identified: constraints to educational feasibility, feasibility study methods, and sources of feasibility determination data. One way of examining the inter-relatedness of these facets is through use of a framework. Subdividing each facet of feasibility by the elements derived from the literature review yields the conceptual framework for studying educational feasibility shown in Figure 1.

One of the risks associated with development of a matrix or cubic model is that some of the cells may be meaningless. The conceptual framework is no exception—the shaded cells representing “theoretical demonstration” serve as an example. There may be others, although they are not so obvious.

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Alberta Advisory Committee for Educational Studies—Funded Research

The Alberta Advisory Committee for Educational Studies was formed in 1953 to further educational research. It has provided financial support for publications which disseminate reports of educational research. It has also operated as a granting agency to provide funds for small scale studies in education. The following is a list of current studies being supported by A.A.C.E.S. Some are just being initiated while others are nearing completion. Those interested in further information are advised to contact the particular researcher at the address indicated.

Bergen, J. J. Department of Educational Administration
The University of Alberta, Edmonton, Alberta.

"The Development of Simulation Materials Focusing on the Problems of Classroom Teachers"

Bhattacharya, N. C. Department of Educational Foundations
The University of Alberta, Edmonton, Alberta.

"John Dewey: A Critical Study"

Blowers, E. Department of Educational Psychology
The University of Alberta, Edmonton, Alberta.

"An Investigation of the Visual Tracking Syndrome"

Bride, K. The Alberta Teachers' Association
11010 - 142 Street, Edmonton, Alberta.

"Teacher Education Toward the Year 2000: The View of Canadian Teacher Organizations"

Cameron, J. R. Department of Curriculum and Instruction
The University of Calgary, Calgary, Alberta.

"A Guide to Publishing in Education"

Castonguay, T. Grant MacEwan Community College
Edmonton, Alberta.

"Computerized Item Retrieval of Medical-Surgical Nursing Test Items"

Clark, A. K. Department of Industrial & Vocational Education
The University of Alberta, Edmonton, Alberta.

"The Readability of Recommended Texts in Industrial Education Programs"

Das, J. P. Centre for the Study of Mental Retardation
The University of Alberta, Edmonton, Alberta.

"Comprehension and Memory of Syntagmatic and Paradigmatic Groups of Words"

Dueck, K. G. Department of Curriculum and Instruction
The University of Calgary, Calgary, Alberta

"The Status of Geographic Education in Canada: Research and Teaching"

Funded Research

- Everett, L. Department of Elementary Education
The University of Alberta, Edmonton, Alberta
"A Curriculum Model for the Use of Learning Centres in Early Childhood Teacher Preparation"
- Fris, J. Department of Educational Administration
The University of Alberta, Edmonton, Alberta
"Professionalism and Militance Among Alberta Teachers"
- Goodman, H. J. A. Department of Curriculum and Instruction
The University of Calgary, Calgary, Alberta.
"The Development of Concepts Concerning the Establishment of a World Education/Information/Research and Encyclopedia System-Network"
- Gordon, I. Department of Educational Foundations
The University of Calgary, Calgary, Alberta.
"A Crosstemporal Study of Equality of Educational Opportunity for Girls Within the Calgary High Schools: 1926, 1936, and 1946"
- Guay, J. Faculty of Education
The University of Lethbridge, Lethbridge, Alberta.
"Biology and Life Science Classroom Teaching Environment in Zone 6"
- Guay, M. Faculty of Education
The University of Lethbridge, Lethbridge, Alberta.
"Relations Between Psychological Test Performance at Admission and Student Teaching Performance"
- Gupta, K. R. Department of Educational Psychology
The University of Alberta, Edmonton, Alberta.
"Testing and Testing Personnel in Edmonton and Calgary"
- Holdaway, E. A. Department of Educational Administration
The University of Alberta, Edmonton, Alberta.
"The Satisfaction of Teachers in Alberta with Their Work and Conditions of Employment"
- Holliday, W. G. Department of Curriculum and Instruction
The University of Calgary, Calgary, Alberta.
"Different Study (Mathemagenic) Questions and Science Explanatory Illustrations"
- Kirman, J. M. Department of Elementary Education
The University of Alberta, Edmonton, Alberta.
"Preparing Teacher Candidates to Use ERTS Maps"
- Koch, E. L. Department of Educational Administration
The University of Calgary, Calgary, Alberta.
"Machiavelli and the Principal: Perceptions of Administrative Effectiveness and Dispositions on the Part of School Administrators Toward Manipulative Values in Human Relations"

Alberta Advisory Committee for Educational Studies

- Konrad, A. G. Department of Educational Administration
The University of Alberta, Edmonton, Alberta.
"Trustees in Alberta Public Colleges"
"Professional Development Needs of Administrators in Post-Secondary Education"
"The Deanship in Canadian Higher Education"
- MacKay, A. Department of Elementary Education
The University of Alberta, Edmonton, Alberta.
"A Descriptive Study to Determine the Relationships Between Naturally Occurring Teaching Behavior and Student Outcomes"
"A Description of Classroom Behaviors Across Grade Levels and Subject Areas"
- McIntosh, R. G. Department of Educational Administration
The University of Alberta, Edmonton, Alberta.
"Ethical Dilemmas in Administrative Action"
- Miller, V. K. Faculty of Education
The University of Lethbridge, Lethbridge, Alberta.
"A Survey of Music Education in Zone 6"
- Nixon, M. Department of Educational Administration
The University of Alberta, Edmonton, Alberta.
"Values, Beliefs and Aspirations of Prospective Teachers"
- Olson, A. T. Department of Secondary Education
The University of Alberta, Edmonton, Alberta.
"An Analysis of Mathematics Anxiety in Elementary Education Students and An Assessment of Systematic Desensitization Therapy on Those Students Most Highly Anxious About Mathematics"
- Orteza, E. M. Department of Educational Foundations
The University of Calgary, Calgary, Alberta.
"An Inquiry into Educational Facts"
- Patterson, R. S. Department of Educational Foundations
The University of Alberta, Edmonton, Alberta.
"Participant Perspectives on the History of Schooling in Western Canada: 1900-1945"
"The Impact of Progressive Education on Canadian Schooling"
- Rooney, S. E. Education Library
The University of Alberta, Edmonton, Alberta.
"Creation of a Computer Retrievable Thesis K.W.I.C. Index"
- Small, J. M. Department of Educational Administration
The University of Alberta, Edmonton, Alberta.
"What is the Appropriate Role of the University of Alberta for Service to Lifelong Education?"
- Whitehead, R. Faculty of Education
The University of Lethbridge, Lethbridge, Alberta.
"A Pilot Study to Determine Criteria and Techniques for Evaluating Success of Teachers"

Funded Research

Young, D. R. Department of Industrial & Vocational Education
The University of Alberta, Edmonton, Alberta.

“A Survey of the Supply and Demand of Vocational Guidance Personnel in Canada”

Yewchuk, C. R. Department of Educational Psychology
The University of Alberta, Edmonton, Alberta.

“The Role of Sex and Intelligence in Moral Development of Normal Educable Mentally Retarded (EMR) Children”

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Cultural Variables in Conservation: A Model For Cross-Cultural Research

A cross-cultural model for development of conservation has been proposed from a review of previous researches. The model accepts Elkind's (1967) distinction between identity and equivalence conservation and also draws from Furby's (1971) analysis of cross-cultural factors. Cultural, ecological, and educational variables in relation to magical thinking, perceptual flexibility, and logical reasoning seem to be crucial in development of children's judgments and explanations in conservation tasks. Some variations to the standard testing procedure viz., screening and self-transformation, have been suggested to test the hypotheses derived from the model and also as training techniques suitable for cultural differences in children. (Mr. Mohanty is a doctoral student and Dr. Stewin is Associate Professor in the Department of Educational Psychology at the University of Alberta.)

Piaget's stage-invariant theory of cognitive development has often been dubbed as one too much dependent on biological maturational processes. Certainly, Piaget's theory reflects his belief in a significant role of natural biological growth process and can be placed on one side of the continuum, the other side of which is represented by Bruner's (1964; Bruner, Olver & Greenfield, 1966) emphasis on the role of language and other cultural factors. A careful analysis of Piaget's theory reveals that he is not as extreme a maturationist as many would like to believe. One reason for the widespread misconception of Piagetian theory is that most studies using Piaget-type tasks also used "average western subjects." This built-in homogeneity among subjects resulted in finding spurious *universality* in the age-stage relationships and in the sequence of various cognitive abilities. Recent replications of these studies in nonwestern societies show that the rate of cognitive development is dependent upon various experiential and ecological variables, whereas developmental sequences are perhaps largely predetermined. These findings, however, do not limit the generality of

Piaget's theory since he never claimed that cognitive development is determined *only* by biological (maturational) processes. Piaget (1966) outlined four types of factors, the interaction of which determines the nature of cognitive development: (1) biological factors; (2) equilibration factors; (3) social (interpersonal coordination) factors; and (4) factors of educational and cultural transmission. The last two of these factors are complex and multidimensional and, in fact, may be responsible for any intercultural difference in the development of cognitive abilities. Dasen (1972) notes that studies can be cited to support any of the following possibilities: that conservation and other cognitive abilities of nonwestern children compared to western children develop (a) at the same time (Price-Williams, 1961; Goodnow, 1962); (b) earlier or more quickly (Tuddenham, 1969); (c) later or more slowly (Greenfield, 1966; Greenfield & Bruner, 1966). These possibilities implicitly assume that the final level of attainment is universally comparable. A fourth possibility has also been shown to exist: (d) that certain nonwestern groups never reach the cognitive level of westerners; in fact, they do not develop beyond the early concrete operational stage (de Lemos, 1969). Some studies even report loss or "regression" to an earlier stage of development (Kohlberg, 1968). Clearly, the interaction between culture and cognitive growth is far more complex than a mere western-nonwestern dichotomy.

Conservation Tasks and Problems in Cross-Cultural Comparison

The clinical procedure involved in the administration of Piagetian tasks has been seen as a boon to cross-cultural testing. These tasks are noted for their flexibility of use in widely different cultures as well as for their potentiality in measurement of cognitive development. But unfortunately the flexibility became too loose to result in comparable data and to minimize Type I and Type II errors. For example, there has been no consensus as to whether judgment or explanation of judgment is the minimum condition for inference about cognitive structure. Brainerd (1973) tried to resolve this controversy primarily between Braine (1959, 1962, 1964) proposing a judgment criterion and Smedslund (1963, 1965) favoring an explanation-of-judgment criterion. Brainerd concluded:

- a) the theory (of Piaget) not only fails to justify an explanation criterion, but makes such a criterion seem highly inappropriate to the task of determining the presence of cognitive structure; b) the judgment criterion seems well-suited to the task of determining the presence of cognitive structures. (p. 177)

Of course, an explanation-via-language criterion may be sometimes misleading because it may depend upon the capacity of the cognizer to verbalize his *inner structure* and also, verbalized explanations may be prone to subjective interpretations. As an illustration, direct action explanations ("You poured them" or "You can squeeze it back to previous shape", etc.) have been considered as "primitive" and involving magical thinking in some conservation studies (Greenfield, 1966; Lloyd, 1971). Brainerd (1973), on the other hand, argues that such explanations show "inversion reversibility" and are adequate. Interpretation of verbal explanations in Piaget-type tasks (in any testing situation, for that matter) may thus be controversial if not erroneous. In spite of that, the information that can be gained from explanations given by a child about how he arrived at a

judgment may be too valuable to ignore on these grounds. Brainerd (1973) hastens to add:

Explanations can supplement judgment in such a way that one is provided with insight into the nature of the structure or structures under consideration. (p. 178)

Explanation may at times be more important than judgment itself and therefore, choice will largely depend upon the type of interest in a testing situation and not necessarily on any absolute criterion. Given a basic agreement in interpretation of various explanations, it may be of importance to find out the type of explanation across cultures and, through them, to show how cultural forces operate and interact to produce a definite cognitive structure. Many such problems can be identified in Piagetian tests. Lloyd (1972) and Dasen (1972) reviewed the cross-cultural findings on horizontal *decalage* and showed the lack of agreement in the sequence of difficulty of various conservation problems between different cultures. Ideally, cross-cultural comparisons should establish the generality of a theory when agreement across cultures is found, or else they should be able to modify and improve the theory by pinpointing the factors that operate at variance, when cross-cultural differences are obtained. But unfortunately the significant independent variables are not isolated and are, more often than not, subsumed under a gross label—"culture." Such gross independent variables are not independent in the sense of their explanatory values. Very often, a post hoc explanation of the finding is offered in terms of some specific variables that *might possibly* be operating within the culture and this adds to the confusion it seeks to solve. Based on a review of several studies on conservation, a cross-cultural model for the development of conservation ability has been attempted in this paper in terms of different cultural variables that might be specifically related to conservation.

Culture and Conservation—Some Significant Variables

Elkind (1967) analyzed the logical steps involved in a Piagetian conservation task and distinguished between identity conservation and conservation of equivalence. Identity is "conservation of a given quantity across a reversible transformation and with respect to itself alone"; equivalence is "the invariance of quantitative relation across a transformation of one of the elements of that relation" (p. 25). A typical conservation task involves the following steps. First, the subject is satisfied that a standard (S), A, and a variable (V), B, are the same on any dimension (e.g., length, number, quantity, etc.). Second, the variable is then transformed from V to V_1 . Third, the subject is asked to judge $S = V_1$. According to Elkind, to be able to give a correct judgment, the subject must first judge $V = V_1$ (identity) and then $S = V_1$ (equivalence). In other words, there is a logical priority of identity conservation over conservation of equivalence. Hooper (1969) also demonstrated the developmental priority of identity judgment over equivalence judgment. Identity judgment, in turn, depends upon the schemata of reversibility and invariant quantity and this is where the impact of cultural and socialization processes appears to be crucial. Furby (1971), in her review of cross-cultural research on conservation, showed that in some cultures *magical thinking* is an essential element of a child's cognitive structure and this may affect his judgment of identity. Magical thinking can be thought of as a child's belief that the unusual and the

irrational can and do happen and that the experimenter may have the power to make them happen. In Greenfield's (1966) study Wolof children, in comparison to American children, gave more direct action reasons in support of conservation, thus displaying a greater degree of belief in the external control of events and magical thinking. The writers would like to add that a magical element is part of almost all cultures with a tradition of stories wherein a person is helped by an omnipotent being. External control factors such as fate, magic, and miracles are often reflected in folk tales, religion and other cultural rites and rituals and are transmitted in some form to the child. The real difference, therefore, is how actively adults inhibit or induce this magical element in a child's thinking. Further, magical thinking is reflected not just in nonconservation explanations but in conservation explanations as well. If a magically thinking nonconservers says, "There is more because you poured it", a conserver might also say, "You can pour it back and they will be the same." Both the explanations reveal the degree of belief in an external factor or in the (magical) power of the experimenter. However, in the conserver's thinking, the concept of reversibility interacts with the magical element. Direct action reasons can thus reflect primitive thinking, although the line of distinction is very subtle.

Once the subject has judged the identity his next task is to judge equivalence. This task, in fact, involves a deductive reasoning process which must proceed in the following way: $S = V$, $V = V_1$, therefore, $S = V_1$. This reasoning has to prevail in spite of perceptual differences between S and V_1 . In other words, perceptual flexibility is a necessary precondition to logical reasoning in conservation of equivalence. Thus, the impact of school education and acculturation on reasoning ability may not show up in a young child who is otherwise perceptually rigid. In Goodnow's studies (1962; Goodnow & Bethon, 1966) low SES Chinese children with no schooling were as good conservers as Hong Kong-European and American children. Goodnow notes that Chinese children were perceptually more flexible with their "catty carrying experience." The experience of carrying a catty of rice in bags of varying shapes and sizes may have helped them in their judgment of quantity in relation to various perceptual cues. In Price-Williams' (1961) study, unschooled Tiv children in central Nigeria did not differ from schooled western children in conservation ability. Greater perceptual flexibility of Tiv children due to a manual action-oriented environment seemed to compensate for the lack of schooling. Furby (1971) draws support from studies by Goodnow and Greenfield to argue that the effect of schooling can only be seen in the context of environmental influence on perceptual flexibility. She writes:

. . . . the level of technical-development-dimension involves the degree of perceptual flexibility the child has acquired. The child in a manually-oriented environment is much more likely to have the ability than the child in a more automated environment, due to a difference in the amount of interaction with the environment which leads to the ability to accurately assess object properties using perceptual attributes. (p. 247)

Thus, ability to judge equivalence in terms of shape, size and other perceptual dimensions rather than being rigidly fixed with one single attribute may come through direct environmental experience even without

schooling. Unschooling “catty-carrying type” children may not differ from or even may be superior to western children at an earlier age. But gradually the impact of school and informal education in home and outside environment will help the latter get rid of perceptual rigidity and develop logical reasoning. So, at a later age, western children may be superior to other unschooled children in primitive societies. Effect of schooling, type of environment, and age will thus interact to produce different results in cross-cultural comparison. As Furby has shown, analysis in these terms can explain the apparent contradiction in cross-cultural studies.

With reasoning ability and perceptual flexibility supplementing the identity concept, conservation of equivalence is the next logical development. The child can now judge $S = V_1$ and must use his verbal ability to explain his judgment.

Figure 1 gives a schematic representation of the proposed model. Three factors within a given culture (including ecological, educational and sociological factors like type of environment, schooling and acculturation) stand out in the model. They are:

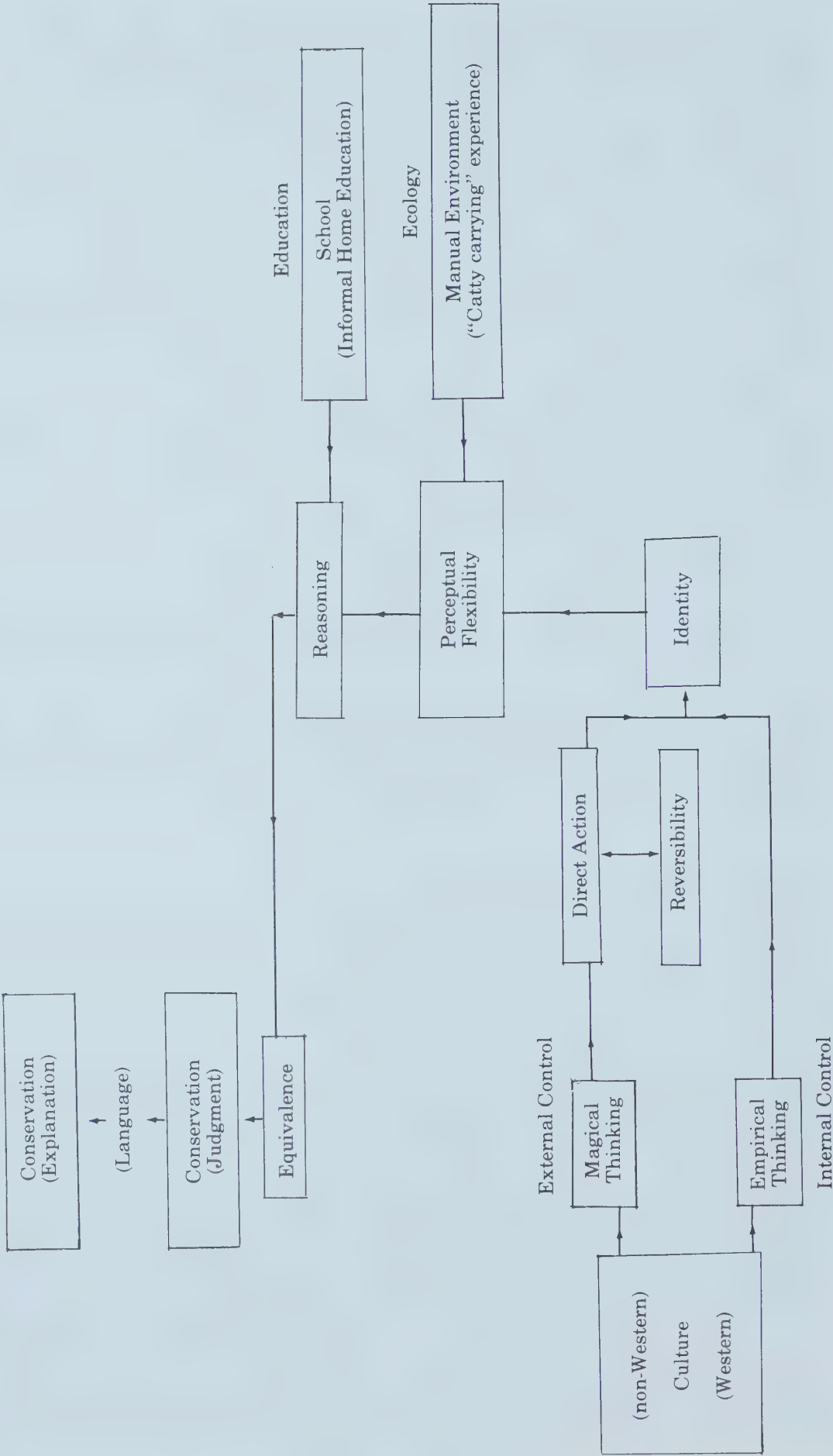
- (i) Cultural influence on magical thinking;
- (ii) Early experience in a manual environment and later schooling facilitating perceptual flexibility;
- (iii) Formal schooling and other informal educational experiences within a culture inhibiting earlier magical thinking and developing reasoning ability.

Some possible implications of the model for cross-cultural comparison of conservation abilities can now be discussed in relation to the factors described above. In addition, some methodological variations to the tests of conservation will also be considered to demonstrate the role of these variables.

Magical thinking and conservation

The proposed model suggests that in cultures where primitive magical thinking is predominant and where the environment offers little in terms of perceptual experience, children are likely to be delayed conservers compared to western children. Primitive and magical elements in a culture can be shown to be reflected in an external locus of control dimension in the personality of children who are more likely to attribute magical powers to the experimenter and experimental situation as a whole. Children in such cultures, therefore, can be expected to give more direct action explanations for their nonconservation as well as conservation judgment, by referring to the act of the transformation by the experimenter himself. For example, a typical explanation of a nonconservation would be, “You made it more.” Conservers’ direct action reasons may be frequently like this statement: “You just rolled it, so they are the same.” Some distinction ought to be made between direct action reasons given by conservers and nonconservers. The same type of statement can be given in support of different judgments but in case of the former, perceptual flexibility and reasoning ability are sufficiently developed to the extent of inhibiting the effect of magical thinking. However, the influence of magical elements can still be observed through more elaborate language mechanisms. At this point, the authors

FIGURE 1
CROSS-CULTURAL VARIABLES IN DEVELOPMENT OF CONSERVATION



would like to reiterate the necessity of using an explanation criterion in cross-cultural studies. As has been discussed earlier, there is some doubt as to the adequacy of direct action reasons. Some authors (Brainerd, 1973) do not see anything "primitive" about a direct action explanation. It can be pointed out that direct action reasons may not be "primitive" when they show "inversion reversibility", eg., when a conserver says, "You can pour it back and make them equal." Obviously, such statements show some logical process but it is still hard *not* to see the emphasis on the action of the experimenter and the power attributed to him. This assertion can be tested by comparing the number and type of direct action explanations of conservation given by children in traditional mystic cultures with those of western children.

Role of perceptual factors in conservation

Although magical thinking is likely to have an interfering effect on the development of conservation ability in most of the nonwestern cultures, a highly action-oriented manual environment would induce perceptual flexibility in the children quite early in life. Western children, on the contrary, are more likely encouraged to inhibit their magical thinking, but perceptual flexibility may develop much later. Thus developmental differences in the type of conservation/nonconservation explanations can be expected. Western children may be expected to give more perceptual explanations with their nonconservation judgments, referring to the perceptual discrepancy as explanation of nonequivalence. They may not get rid of this perceptual rigidity without formal school education which has been shown to have definite influence on perceptual information processing and logical reasoning processes (Bruner et al., 1966; Schmidt, 1960, 1966). In certain nonwestern societies even the unschooled children of early school age can be expected to show conservation which is better than, or at least as good as, that of western schooled children of the same age because the former do not need schooling for the development of perceptual flexibility which is induced through direct experience in a manual "non-carpentered" environment. However, with increasing years of schooling, the western children may soon compensate for lack of this early experience, and the gap due to the effect of perceptual flexibility may be reduced.

The foregoing discussion assumes that perceptual factors are important in conservation task. Hooper (1969), however, argued to the contrary. He found no difference between the effects of moderate and extreme transformation in conservation test. Screening of standard stimulus container prior to transformation was shown by him to have no effect on conservation. It must, however, be remembered that the difference between moderate and extreme transformations as in Hooper's study may not necessarily be analogous to differences between some and no perceptual cues and, besides, screening of the standard container before transformation cannot eliminate the information regarding perceptual disparity because the subjects would still remember the height of the substance in the screened container. Further, even if perceptual factors may not be important in the case of schooled western children, the same cannot be said of unschooled children of other cultures.

Cultural influence and training for conservation

Two factors affecting conservation have been shown to be identifiable from the explanations given by the nonconservers, viz. magical thinking and perceptual rigidity. An extended testing procedure will be suggested here to detect these factors and possibly eliminate their effects at least in case of children who are in a transition from identity to equivalence conservation or whose conservation judgments are inhibited by their magical thinking. The extended testing procedure will be illustrated with conservation of continuous quantity (water) problem. The first step in this procedure is Frank's screening procedure (cited in Bruner, 1964), in which water is poured by the *experimenter* from the wider glass to the narrower and taller glass behind a screen with the top of the taller glass visible to the subject, who is then asked to judge the equivalence of the quantity. Although the subjects should be able to infer the width and height of the screened glass from its visible top, those who have trouble with disparate perceptual cues should find it easier to give a conservation judgment because the height of the water level in the new container is not visible. The screen may then be removed and some subjects will perhaps change their judgment depending upon how much their judgment is tied up with misleading perceptual cues. The procedure may be repeated for such subjects.

The second step in the extended testing procedure is to ask the nonconservers (particularly those giving direct action explanations) to effect the transformation themselves. This may help the subjects get rid of their magical belief by assuming greater self-control over the experimental situation. Self-transformation may also help the subjects internalise the operation involved and thus give a conservation judgment. A number of repetitions of this procedure may be necessary before the subjects can assimilate the fact that they do not add anything to the amount of water in the previous container. It may also be necessary to combine the two steps for greater effectiveness. In such cases, the subjects would be required to pour water from one container to the taller and narrower container when the latter is behind a screen with only its top visible to them. Following repeated trials and a possible correct judgment, the *experimenter* may go back to either Step 1 or Step 2. Inversion or empirical return (pouring the water from taller and narrower glass back to the original container) have also been used to induce conservation (Schnall, Alter, Swanlund & Schweitzer, 1972). Such a technique can fight the magical factor in a nonconservers' thinking process. However, these methods of training for conservation may have differential impact in different cultures depending upon the extent to which training is directed at the specific area of deficit of the child in a given culture. Screening may be more effective with western children whereas self-transformation experience is more likely to change nonconservation judgments in most nonwestern societies. In terms of long term implications for cognitive development it might be expected that educational systems directed towards development of logical reasoning (and simultaneously reducing magical thinking) would be most effective in nonwestern underdeveloped societies.

In summary, the proposed model of attainment of conservation ability

takes into account the possible effects of magical thinking, perceptual flexibility, and logical reasoning, all induced by and within the culture. An analysis has been made on the basis of an earlier formulation by Furby (1971). The model accepts Elkind's distinction between identity conservation and conservation of equivalence and also assumes logical and developmental priority of the former. It seems possible that the factors outlined above operate hierarchically and therefore, attainment of conservation may depend upon the lower order conditions being adequately built up in the child. Perceptual flexibility and reasoning ability, for example, would help a child only after magical elements in his thinking have been effectively reduced and identity conservation established. The contention of hierarchy in the model, however, lacks empirical support at present and has to be verified through deliberate training attempts like the ones suggested here. In conclusion, it can be pointed out that the model seems to have some prima facie validity for cross-cultural comparison of conservation. Although Piaget's theory does not deny significance to cultural and educational factors in development of conservation, few attempts have been made to study systematically the role of specific cultural variables to find out how they relate to children's conservation/nonconservation judgments and explanations in different cultures. It is hoped that the model discussed here would provide a conceptual framework for such analyses.

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Functional Reading Levels: From Graded Word Lists?

This study investigated the relationship of functional grade placements derived from a full scale informal reading inventory, the Standard Reading Inventory (SRI), and grade placements derived from the word list subtest alone.

One hundred forty-six students in grades one through six were tested. Multiple regression analysis indicated a high relationship between the full scale SRI and the word list alone. Consequently a rule of thumb was derived for the quick estimating of reading levels. (Dr. Froese is Associate Professor in the Department of Curriculum, Faculty of Education, The University of Manitoba.)

Graded word lists are commonly used to match students with instructional materials. Word lists such as the San Diego Quick Assessment (LaPray & Ross, 1969), the Graded Word Reading Test (Schonell, 1966), and the Dolch Basic Sight Word Test with McBroom, Sparrow and Eckstein criteria (Zintz, 1972) result in grade levels or book levels. Furthermore, informal reading inventories such as the Standard Reading Inventory (McCracken, 1966), the Classroom Reading Inventory (Silvaroli, 1969) and others utilize graded word lists as starting level guides for oral and/or silent paragraph reading.

The existence and utility of these instruments suggest a close relationship between scores on graded word lists and functional reading performance. If this assumption is justified, may functional reading levels be accurately estimated from word reading tests?

This study sought to answer the questions: May functional reading levels (independent, instructional, frustration) be predicted from word recognition tests? If so, how accurately do they predict these levels?

In particular, this study investigated the feasibility of using the McCracken Word List (MWL), a subtest of the Standard Reading Inventory, since it is one of few with adequately documented reliability and validity (McCracken, 1963). MWL results have also been shown to be highly

correlated to other widely used word lists, although the absolute placement may vary significantly among tests (Froese, 1971).

Hypotheses

1. There is a significant correlation between word recognition test results and extended reading as required in the Standard Reading Inventory.
2. All functional levels—independent, instructional, frustration—may be predicted from the word recognition test results.
3. Alternate scoring procedures for the word recognition tests may result in higher predictive validities.
4. Functional reading estimates may be made from word recognition test results.

Sample

The 146 subjects in this study were enrolled in a campus school in Washington State. A full range of IQs slightly skewed toward the upper end was represented with a mean of 118 on the California Test of Mental Maturity. Grades one through six were represented (Gr. 1, $N=25$; Gr. 2, $N=24$; Gr. 3, $N=25$; Gr. 4, $N=25$; Gr. 5, $N=23$; Gr. 6, $N=24$).

Methodology

The word list and reading level results of 146 individually administered Standard Reading Inventories (SRIs) were analyzed to give the information below. It should be noted that items 1, 2, 3, 4, and 6 are scored as outlined in the SRI Manual (McCracken, 1966). Pages two and three on the test contain a General Scoring Sheet which simplifies the interpretation of raw scores to the items below without calculation.

1. Independent reading level: The highest book level at which the child rates as independent in all subtests (using SRI scoring procedures and criteria). At primer and first reader levels, silent reading rate must at least equal the oral reading rate; at higher levels, silent rates must exceed oral rates.
2. Minimum instructional level: The book level immediately above the child's independent level.
3. Maximum instructional level: The book level immediately below the frustration level.
4. Frustration level: Several conditions will result in frustration level ratings. The subject may (a) score at the frustration level in one subtest, (b) have half or more of his scores fall under the questionable instructional category at a book level, or (c) have the vocabulary, errors, comprehension or speed areas fall under questionable-instructional at two consecutive reader levels (in which case the frustration level is at the higher of the two reader levels).
5. Number of words correct on each grade level list attempted: The pre-primer list contains fifteen words, the remaining ten lists each contain twenty-five words.
6. Grade level at which the MWL was terminated (stopping level): The MWL is continued until the child makes eight successive errors or until less than half the words on a list are pronounced correctly.

7. Sum of correct responses to stopping level: This is the total of all correct responses up to and including the stopping level. If a student's MWL is begun at the first level (or some other level) it is assumed that he would have scored correctly on the preceding (lower) lists.

Weighted scores were assigned to the commonly used book levels for purposes of statistical analysis:

PP = 1.1	1st = 1.7	3-1 = 3.2	5th = 5.5
P = 1.4	2-1 = 2.2	3-2 = 3.7	6th = 6.5
	2-2 = 2.7	4th = 4.5	7th = 7.5

Analysis and Findings

The data were key-punched and submitted to a step-wise multiple regression program which resulted in the following matrix (rounded to three decimal places).

Hypothesis 1 may be tested by referring to Table 1. It can be seen that stopping levels (the point at which word list reading is terminated according to SRI instructions) are highly related ($p < .01$) to all functional reading levels. Correlations range from .825 to .925. This means that a large part of the variance of the full scale SRI is accounted for by the word list and that predictions may be made from the word list (MWL) to the functional levels determined by the complete SRI.

TABLE 1
CORRELATION MATRIX FOR DEPENDENT AND INDEPENDENT VARIABLES
(N=146)

	Ind.	Min. Inst.	Max. Inst.	Frust.	Stopping Level
Sum to Stopping Level	.837	.857	.922	.930	.978
Stopping Level	.825	.822	.878	.925	

All coefficients are significant at .01 level.

Again, referring to Table 1, one may examine Hypothesis 2. When word list stopping levels are considered in relation to individual levels, it is noted that each correlation is significantly different from zero. That is, from "sum to stopping level" one may predict the independent level, the minimum instructional level, the maximum instructional level, and the frustration level on the full-scale SRI. The same holds true for the "stopping level" although the correlation coefficients are slightly lower.

To test the third hypothesis, it is necessary to use a statistical procedure (McNemar, 1969) which takes into account the fact that sum to stopping level and stopping level are correlated. Since the maximum instructional level is the most important level for classroom teachers, the two coefficients (for the two scoring systems) were compared. It is noted that sum to stopping level is correlated .922 with maximum instuctional level and .878

with stopping level. When the difference of these two scores is tested by the procedure mentioned above, a *t* score of 7.40 with 143 *d.f.* results. This difference is significant beyond the .01 level. Sum to stopping level consequently appears to be a better predictor than stopping level.

The fourth hypothesis is somewhat more difficult to settle since comparisons are not available. That is, how closely should estimated levels based on word lists agree with the actual reading of extended discourse before they are acceptable as estimates? Table 2 indicates that if one is willing to accept the true functional level plus or minus one *level* (e.g., PP, P, 1, 2-1, 2-2, 3-1, 3-2, 4, 5, 6, 7) one's instructional level estimate would be correct in approximately 80% (10.3% + 41.8% + 27.4%) of the cases studied.

TABLE 2
COMPARISONS OF INSTRUCTIONAL LEVEL ESTIMATES TO
FULL SCALE SRI PLACEMENTS

	One Level Below	On Level	One Level Too High
Grade 1	2	14	8
Grade 2	1	10	9
Grade 3	1	3	10
Grade 4	4	10	3
Grade 5	5	10	6
Grade 6	2	14	4
	15/146	61/146	40/146
	10.3%	41.8%	27.4%

Since readability formulas used for determining the difficulty of reading materials (and subsequently for matching of readability and reading level) are seldom more accurate than plus or minus one grade level, one may consider such a range of error to be acceptable for classroom estimation purposes.

A rule of thumb may hence be applied: Instructional Level Estimate = stopping level - one level; Frustration Level Estimate = stopping level; and Independent Level Estimate = stopping level - four levels (or the lowest level on the SRI). It should be reiterated that this procedure is intended only for quick placement and does not provide the wealth of diagnostic information that the full-scale SRI provides.

Discussion and Implications

Frequently it becomes necessary for the classroom teacher or reading clinician to estimate a tentative reading level for immediate instructional purposes. Under these circumstances, graded word lists are often used. This study was undertaken to clarify the soundness of such a procedure.

It has been demonstrated that a highly significant relationship exists between word list reading and reading of extended discourse. While this is not surprising, the predictive validity for estimating functional reading

levels has not been widely publicized. Furthermore, a high relationship among scores does not provide information about the calibration required. This investigation suggests that Functional Reading Level Estimate = stopping level - one level may be an adequate criterion to use with the SRI word list until further information is gathered by the teacher to reject or confirm the tentative placement.

The above generalizations should not be extended to other word lists until their relationships to specific materials are ascertained. While various word lists result in scores that correlate moderately, the absolute grade equivalents may be significantly different (Froese, 1971).

This study also indicated that the procedure "sum to stopping level" was a slightly better predictor of functional reading levels than stopping level alone and may consequently be a useful refinement for research purposes.

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The Disturbing Child: What You See is What You Get?

The ratings of special education teachers, regular education teachers, and teachers-in-training were compared with regard to the relative disturbingness of certain behaviors. The results indicated that regular teachers found the behaviors more disturbing than either of the other groups. The implications of these results are discussed with regard to ecological intervention strategies and teacher training practices. (Dr. Algozzine is Assistant Professor in the Department of Special Education at the University of Florida, Gainesville.)

Pate (1963) suggested that a child was emotionally disturbed when his behavior was inappropriate and unacceptable to his peers and adults. Such definitions of emotional disturbance stress that the condition exists within the child because the child frequently exhibits an abnormal amount of disturbed behavior. Screening and identification procedures typically rely on checklists and behavior rating scales as the primary means of assessment. This procedure often generates negative consequences for children (i.e., negatively self-fulfilling prophecies, mis-diagnoses, etc.) and has received some criticism (Algozzine, 1976; Reinert, 1976). As an alternative to emphasizing the behavior of the child as being disturbed, Rhodes (1967) offered an ecological explanation for the existence of emotional disturbance. This perspective stresses the interaction between the child's behavior and that of others in the child's ecosystem. He suggested that an individual's behavior may be viewed as disturbing, and as such create an imbalance in the interactions of that person. Rhodes' model has received some support (Reinert, 1976; Rhodes & Tracey, 1972; Swap, 1974) but has only recently been empirically investigated.

Herr, Algozzine & Eaves (1976) have shown that the disturbingness of behaviors can be decreased by an intensive experience with exceptional children. Algozzine (1976) has demonstrated that individuals' attitudes toward behaviors vary as a result of their training and experiences.

The purpose of this investigation was to attempt to determine if regular teachers, special education teachers, and post-student teaching teachers-in-

training held the same attitudes regarding the disturbingness of behaviors characteristic of emotionally disturbed children. The null hypotheses of the study state that there are no differences between the groups' ratings of how disturbing these behaviors were, or between the four dimensions of disturbing behaviors.

Method

Subjects

Twenty-five teachers of regular education classes from several elementary schools in a large metropolitan area, twenty-five special education teachers from the same city, and twenty-five advanced undergraduate students of special education were randomly selected to participate in this investigation. The public school teachers had all been employed for at least one year, and the students had all participated in student teaching; all were considered to be experienced with regard to working with children.

Dependent measure

A modified version of the Behavior Problem Checklist (Quay & Peterson, 1975) had been previously administered to several hundred subjects in an attempt to validate its use as a Disturbing Behavior Checklist (Algozzine, 1976). This scale appears to be a valid and reliable measure of the relative disturbingness of certain behaviors; social facility, social defiance, physical symptom and socialized delinquent dimensions were represented by the scale. The reliability coefficients (KR20) of the four factors ranged from .62 to .93.

Procedure

The seventy-five subjects were asked to complete each item of the Disturbing Behavior Checklist (DBC) with regard to how disturbing each item was in working with children. Since the four factors of the DBC have different numbers of items, factor means were derived for each subject by dividing the total score on the factor by the number of items in the factor. A two-factor analysis of variance with repeated measures was utilized to determine if differences in the disturbingness of items existed between groups of subjects and dimensions of the DBC. Because of the investigative nature of this study, stringent criteria for significance were judged necessary. The level of rejection was set at .01 and an additional criterion of at least a 0.5 unit difference between means was established to test the significance of any obtained difference. The latter criterion represented a relative difference of one-half of the distance between points on the dependent continuum, and as such was judged representative of a meaningful change in responses.

Results

The means and standard deviations for the subjects' responses to the disturbing behaviors are presented in Table 1. Analysis of variance results indicated significant main effects ($p < .01$) for the subject group and DBC factors. Analysis of overall means indicated that the regular teachers ($\bar{X}=3.2$) found the behaviors more disturbing than either the special teachers ($\bar{X}=2.6$)

TABLE 1
MEANS AND STANDARD DEVIATIONS OF RESPONSES TO THE
DISTURBINGNESS OF FACTORIAL BEHAVIORS

Group ^a	DBC Factor			
	Social Facility	Social Defiance	Physical Symptoms	Socialized Delinquent
Special Education Teachers	2.4	3.2	2.4	2.4
Special Education Students	0.6	0.9	0.8	0.9
Regular Class Teachers	2.6	3.1	2.6	2.4
	0.6	0.5	0.8	0.7
	3.0	3.7	3.1	3.0
	0.5	0.5	0.7	0.8

^a For each group, N = 25.

or the students ($\bar{X}$ =2.7); the significance of this difference was established by both criteria for this study. Similar results were obtained in analyzing social defiance in the disturbingness of the factors. The social defiance behaviors (Factor II, $\bar{X}$ =3.4) were significantly more disturbing ($p < .01$, difference > 0.5) than those for the other factors (I, $\bar{X}$ =2.7; III, $\bar{X}$ =2.7; IV, $\bar{X}$ =2.6).

TABLE 2
ANALYSIS OF VARIANCE SUMMARY TABLE FOR DISTURBINGNESS OF
BEHAVIORS BY GROUPS OF TEACHERS AND DBC FACTORS

Source	MS	df	F
<u>Between subjects</u>			
Groups	9.606	2	8.49*
Error	1.131	72	
<u>Within subjects</u>			
Factors	9.390	3	32.37*
Group X Factors	0.226	6	0.78
Error	0.290	216	

* $p < .01$

Conclusions and Implications

The null hypotheses of this investigation were not accepted; that is, the groups *did* significantly vary with regard to the disturbingness of the behaviors and one dimension of those behaviors (i.e., socially defiant) was more disturbing than the others. These results suggest that regular teachers may have a more limited tolerance for disturbing behaviors than either special education teachers or special education teachers-in-training. Rubin and Balow (1971) have suggested that the schools accepted a very limited

range of behaviors when that range was defined by regular teachers. The question of whether this limited tolerance for behavior can result in disturbance remains to be answered; however, it has been shown the individuals found various behaviors differentially disturbing. This may be due to differential experience with special children or to more restrictive background and training. In either case, recognizing that the difference exists is the first step toward reducing it.

The schools do serve a socializing function. It is, therefore, understandable that socially defiant behaviors would be viewed as most disturbing by teachers and teachers-in-training who, in fact, serve as significant agents in the socialization process. These results suggest that it may be necessary to develop training programs which incorporate methods of reducing the behaviors in children, as well as changing teachers' attitudes toward those behaviors. Ecological theorists further imply that effective treatment must consider the child as well as ecosystem members.

If behaviors which are exhibited by children are differentially disturbing to groups of teachers, it may also be that they are differentially disturbing to other types of people. These results generally suggest that it may be possible and profitable to match a child who exhibits certain disturbing behaviors with a teacher who is tolerant or accepting of those same behaviors. This study represents a portion of the groundwork necessary for research attempts to validate such a matching hypothesis. Until that occurs, education is left with the possibility that a child's behavior may be disturbing simply because someone sees it as disturbing.

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Family Socialization and Adolescent Behavior: A Canonical Analysis

Longitudinal data collected on English adolescents were used to examine the extent to which socialization processes in the family were related to the cognitive and affective behavior of the adolescents. The socialization processes were defined in terms of a set of proximal social-psychological variables: parent's aspirations for the adolescent, literacy of the home, parent's interest and support, and a proxy parent-child interaction variable, the reading ability of the adolescents as well as distal structural indices such as social status indicators. Six measures of adolescent behavior were examined: English achievement, arithmetic achievement, nonverbal intelligence, educational and occupational aspirations, attitudes toward school, and self-esteem.

Multiple regression analysis indicated that the socialization indices accounted for a large percentage of the variance in the English, arithmetic and aspiration scores, and a low to moderate percentage of the variance in the other behavior scores. Canonical analysis was used to examine, in greater detail, the covariate structure of the relation between the socialization indices and the behavior variables and it was found that the socialization indices were related differentially to the behaviors. In general, the more proximal social-psychological socialization indices were the best predictors of adolescent behavior, but for an enriched understanding of the relationships, it was necessary to include an analysis of the distal structural indices, especially for the girls. The findings provide support for the proposition that the processes of technical socialization and moral socialization in the family are interdependent. (Dr. Marjoribanks is Professor of Education at the University of Adelaide, Australia; Dr. Walberg is at the University of Illinois at Chicago Circle.)

In his construction of a theoretical perspective to examine socialization processes, Bidwell (1972, 1973) proposes that socialization can be thought of as having two principal aspects. The first is technical socialization which

involves developing intellectual and motor skills and learning items of information and thought that organize them, while the second aspect is moral socialization which is related to the firmness with which a person holds a belief, a value, or an attitude. Although the processes of technical and moral socialization are considered to be interdependent, there is a paucity of research which has examined the relations between family socialization and both the cognitive and affective behavior of adolescents. Generally, socialization studies have concentrated on analyzing either cognitive behavior (e.g., Bing, 1963; Dave, 1963; Vernon, 1969; Marjoribanks, 1972; Walberg & Marjoribanks, 1973) or the affective behavior of adolescents (e.g., Strodbeck, 1958; Rosen, 1959; Weiss, 1969; Kerckhoff & Huff, 1974). Other limitations of much of the research on family socialization and adolescent behavior are related to the use of cross-sectional data to infer longitudinal relationships among the variables and the failure of studies to examine the interrelationships between global indicators of socialization processes, such as social status characteristics, and more social-psychological measures of the processes. Bernstein and Davies (1969) and Halsey (1975), for example, suggest that any treatment of the family needs to include an analysis of both structural social variables and process characteristics. Halsey proposes that "it is essential to insist that the effect of social class on educational experience is not to be thought of as one factor from which parental attitudes and motivations to succeed are independent" (p. 17). He suggests that a theory which explains that adolescent behavior as the outcome of a set of individual attributes has lost the meaning of those structural variables which we know as class. Similarly, in a study of the status attainment of adolescent boys, Wilson and Portes (1975) conclude that while much research has emphasized the importance of social psychological predictors of behavior, it is essential that structural variables such as parental status not be neglected.

In the present study, an analysis is made of the extent to which indicators of the socialization processes in families are related to both the cognitive and affective behavior of adolescents. An attempt is made to overcome many of the limitations of prior research by (a) using longitudinal data, (b) using multiple measures of the cognitive and affective behaviors of adolescents, and (c) defining the socialization processes in the family in terms of both distal indicators such as father occupation, family income and family size, as well as more proximal social-psychological measures such as parents' aspirations for their children, literacy of the home, and parents' interest in education.

Method

Subjects

The data for the study were collected as part of a national survey of school children in England (Plowden, 1967), and then collected as part of a follow-up study on the same children, four years later (Peaker, 1971)

In the Plowden study the sampling procedure had two stages. First, a stratified random sample was taken from all types of government supported elementary schools in England which resulted in the selection of 173 schools. In the second stage of the sampling procedure, a systematic sample of children was chosen from the schools, producing three age cohorts each of

approximately 1,000 children (see Plowden, 1967, volume 2, pp. 147-150). The average age of the senior cohort was approximately 11, of the middle group, eight, and of the junior group, seven. However, for the purpose of the present study, only the children in the senior cohort were appropriate. The final sample included 396 girls and 383 boys who, at the time of the second survey, were in their fourth year of secondary school.

Measures

Family socialization indices. In the first national survey a structured interview schedule was used to gain information about the family environments of the children. The parents were interviewed by government social survey interviewers with each interview lasting, on the average, an hour. For the present analysis, indices were used to assess the structural variables of father occupation, family income, father education, family size, birth order of the adolescent and physical amenities of the home. The social-psychological indices were labelled parents' aspirations for the child, literacy of the home, and parents' interest and support. Also, in the first survey the reading performance of the adolescents was tested using the Watts-Vernon reading test. As many previous studies have shown that measures of parent-child interactions account for large percentages of the variance in the reading achievement of children, it was decided to use the reading scores as a proxy variable to assess in greater detail the socialization processes in the family. The total set of socialization indices used and the items used to assess the social-psychological variables are presented in Table 1.

Cognitive performance. In the follow-up national survey, the cognitive performance of the children was assessed using three measures which all have acceptable reliability estimates: the Alice Heim nonverbal intelligence test (AH4), the Watts-Vernon English comprehension test, and the Vernon graded arithmetic test.

Affective characteristics. In the follow-up survey, three scales were constructed by the National Foundation for Educational Research in England to assess adolescents' education and occupational aspirations, attitudes toward school, and self-esteem. The scales which are of a Likert-type format and of 10 items each are similar to those that have been used in many previous studies. In general, high scores on the questionnaires meant that an adolescent was characterized by a negative commitment to schooling which consisted of (a) a lack of aspirations, (b) negative attitudes toward school, and (c) low self-esteem. A negative commitment indicated that an adolescent (a) had no desire to stay on at school, take university examinations, undertake tertiary education nor planned to study towards an occupation of high social status, (b) didn't think that it was important to do well in schoolwork, was not a hard worker in class, and was not active in class and school activities, and (c) thought that he wasn't a success in school, didn't have much to be proud of, thought that other people did things better than he did, was not satisfied with himself, and didn't think that he had many good qualities. Unfortunately, the data which were obtained from the National Foundation for Education Research in England were in a form which did not permit the reliabilities of the attitude scales to be estimated.

TABLE 1
SOCIALIZATION INDICES AND THEIR RELATED ITEMS

Socialization Indices	
<u>Structural variables</u>	
Father occupation	Family size
Family income	Birth order of adolescent
Father education	Physical amenities of home
<u>Social-psychological variables</u>	
Parents' aspirations for child	
Items: Whether a particular type of secondary school was desired; further education was wanted for child; parents wanted child to take university entrance examinations	
Type of job desired for the child	
Preferred age for child to leave school	
Literacy of home	
Items: Whether the mother or father belonged to a library; the mother read; the father read; the child read at home apart from schoolwork; the child had library books at home	
The number of books in the home	
Parents' interest and support	
Items: Whether the parents played with the child in the evenings; did things with the child at weekends; took an interest in how the child was progressing at school; had visited the school	
Whether the husband helped with caring for the child in the home	
How many hours a week the husband spent away from the family	
Reading achievement at time of first survey	
Items: Proxy variables for family-child interactions	

Therefore the study examined relations between the socialization processes of the family which were defined in terms of father occupation, family income, father education, family size, birth order, physical amenities of the home, parents' aspirations, literacy of the home, parents' interest and support, the early reading achievement of the adolescent, and six measures of adolescent behavior: nonverbal intelligence, English achievement, arithmetic achievement, educational and occupational aspirations, attitudes toward school and self-esteem.

Results and Discussion

The zero-order correlations presented in Table 2 indicate a set of moderate to strong relationships between the socialization indices and the cognitive and affective behaviors. In general, the socialization indices have stronger relationships with the academic achievement measures than with the intelligence and affective scores, which supports the findings of much

TABLE 2
ZERO-ORDER CORRELATIONS BETWEEN THE SOCIALIZATION AND
BEHAVIOR VARIABLES

	Behavior Variables					
	Intelligence	English	Arithmetic	Aspirations	Attitudes	Self-Esteem
<u>Boys</u>						
Father Occupation	20	26	23	-21	-15	-13
Family Income	10	17	17	-23	--	--
Father Education	18	25	27	-26	--	-13
Family Size	-17	-23	-18	17	--	09
Birth Order	--	14	--	--	--	--
Physical Amenities	09	19	18	-18	-14	-10
Parents' Aspirations	21	40	40	-37	-12	-14
Literacy of Home	31	40	34	-37	-13	-14
Parents' Interest	17	28	27	-28	-17	-14
Reading Achievement	24	46	40	-39	-12	-13
<u>Girls</u>						
Father Occupation	23	30	37	-33	-18	-20
Family Income	23	26	30	-36	-10	-19
Father Education	17	23	31	-31	--	-16
Family Size	-09	-24	-23	27	16	12
Birth Order	--	16	--	-15	--	-10
Physical Amenities	12	20	21	-18	-14	--
Parents' Aspirations	37	44	52	-51	-16	-14
Literacy of Home	24	50	40	-40	-12	-19
Parents' Interest	10	20	21	-22	--	-20
Reading Achievement	39	66	60	-58	-27	-26

Note: Decimal points have been omitted.
Only those correlations significant beyond the .05 level are presented.
High scores on the affective characteristics indicate low aspiration,
attitude and self-esteem scores.

previous research (e.g., Dave, 1963; Brookover & Thomas, 1964; Ausubel & Sullivan, 1970; Evans & Anderson, 1973; Jensen, 1973a, 1973b). Also the moderate negative relationships between family size and the behavior measures replicates prior research (e.g., Anastasi, 1956; Cicirelli, 1967;

Kellaghan & Macnamarra, 1972; Dielman, Barton & Cattell, 1974; Marjoribanks, Walberg & Barga, 1975).

When the socialization indices were combined into a set of predictor variables they accounted for a large percentage of the variance in the English, arithmetic and aspiration scores and a low to moderate percentage of the variance in the intelligence, attitudes and self-esteem scores (see Table 3). The findings suggest that the socialization processes operating in the family have a differential impact on measures of the cognitive and affective behaviors of adolescents. But the analysis of the zero-order and multiple correlation provides only a partial understanding of the covariate structure of the socialization indices and the behavior variables. In order to obtain a more enriched understanding of the covariate structure, canonical correlations between the socialization indices and behavior variables were examined. Just as multiple correlation is a generalization of simple correlation in that it relates several predictors to a criterion, canonical correlation is a generalization of multiple correlation in that it relates several predictors to several criteria. Also, just as multiple correlation yields a set of linear weights for the predictors to form a composite variate that is maximally correlated with the criterion, one or more pairs of canonical variates for the predictors and criteria are calculated that maximize the simple correlation between the paired composite variates of each set. Well worked out inferential tests are available to test the significance of successive canonical correlations and the variates may be characterized by calculating the simple correlation ("loading" as in factor analysis) between the composite variate and the original set of variables (e.g., Bock & Haggard, 1968; Darlington, Weinberg & Walberg, 1973).

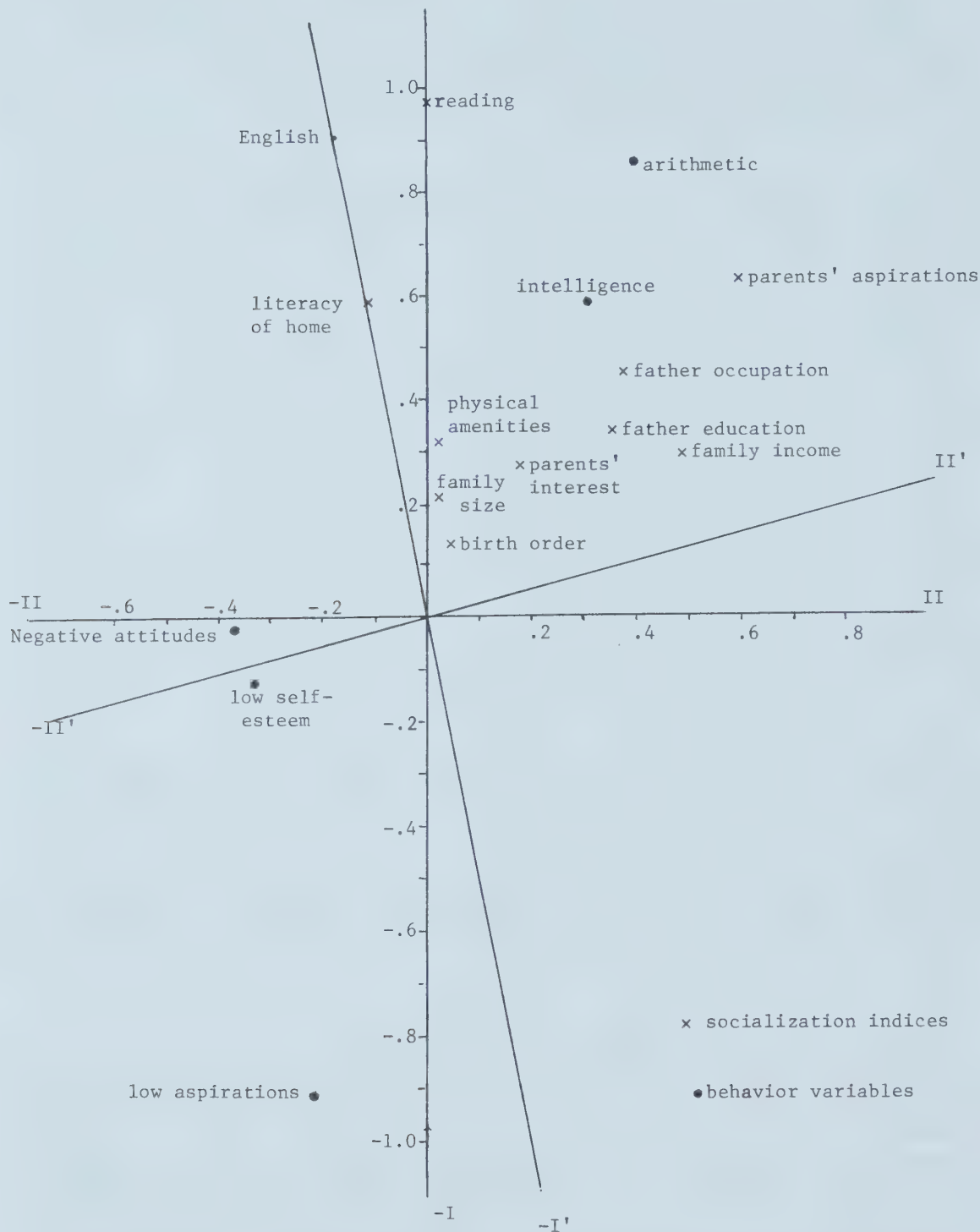
The canonical analysis revealed that for the girls the first two correlations, .870 and .351, were significant (probabilities less than .001). In Figure 1 the canonical loadings have been plotted and for a more interpretable solution, the variates have been rotated orthogonally through English achievement. With respect to the first canonical variate, the loadings suggest that English achievement, arithmetic achievement, aspirations of adolescents and, to a lesser extent, nonverbal intelligence are

TABLE 3
MULTIPLE CORRELATIONS OF BEHAVIOR VARIABLES WITH
SOCIALIZATION INDICES

Behavior Variables	Boys		Girls	
	Multiple Correlation	Percentage of Total Variance	Multiple Correlation	Percentage of Total Variance
Intelligence	.51 ^a	26.17	.52	27.26
English	.86	73.10	.84	71.38
Arithmetic	.71	50.26	.76	57.23
Aspirations	.73	53.11	.75	56.05
Attitudes	.30	9.00	.34	11.57
Self-esteem	.29	8.30	.38	14.14

^a All correlations significant beyond .01 level.

FIGURE 1
CANONICAL LOADINGS OF SOCIALIZATION INDICES AND BEHAVIOR
VARIABLES: GIRLS



related strongly to the early reading performance of the adolescent, literacy of the home, parents' aspirations and father occupation. That is, poor cognitive scores and the lack of educational and occupational aspirations of girls are related to their poor reading ability, a low level of literacy in homes in which fathers have low occupational levels and in which parents have low aspirations for their daughters. By finding a strong association between the aspirations of parents and the girls, the study replicates the results of

research which has examined the influence of "significant others" on the behavior of adolescents (e.g., Rehberg & Westby, 1967; Sewell & Shah, 1968; Sewell, Haller & Portes, 1969; Kandel & Lesser, 1969; Woelfel & Haller, 1971; Williams, 1972). After removing the variance of the first canonical variate from predictors and criteria, the loadings on the second variate indicate that arithmetic, nonverbal intelligence and the three affective behaviors are related to parents' aspirations, family income, father occupation and father education, but not related strongly to earlier reading achievement, literacy of the home and the remainder of the socialization indices.

The analysis of the two canonical variates suggests that the cognitive and affective behavior of girls is related differentially to the socialization indices. English achievement is related strongly to reading performance, literacy of the home, and the social status of the family while arithmetic achievement and, to a lesser extent, nonverbal intelligence are associated with parents' aspirations and the social status of the family. Parents' aspirations, social status of the family and literacy of the home are related strongly to a girl's educational and occupational aspirations and, to a lesser extent, associated with the self-esteem and school attitude scores. Thus the relations between the socialization indices and the behavior variables for the girls provide support for the proposition that the technical and moral socialization processes in families are interdependent.

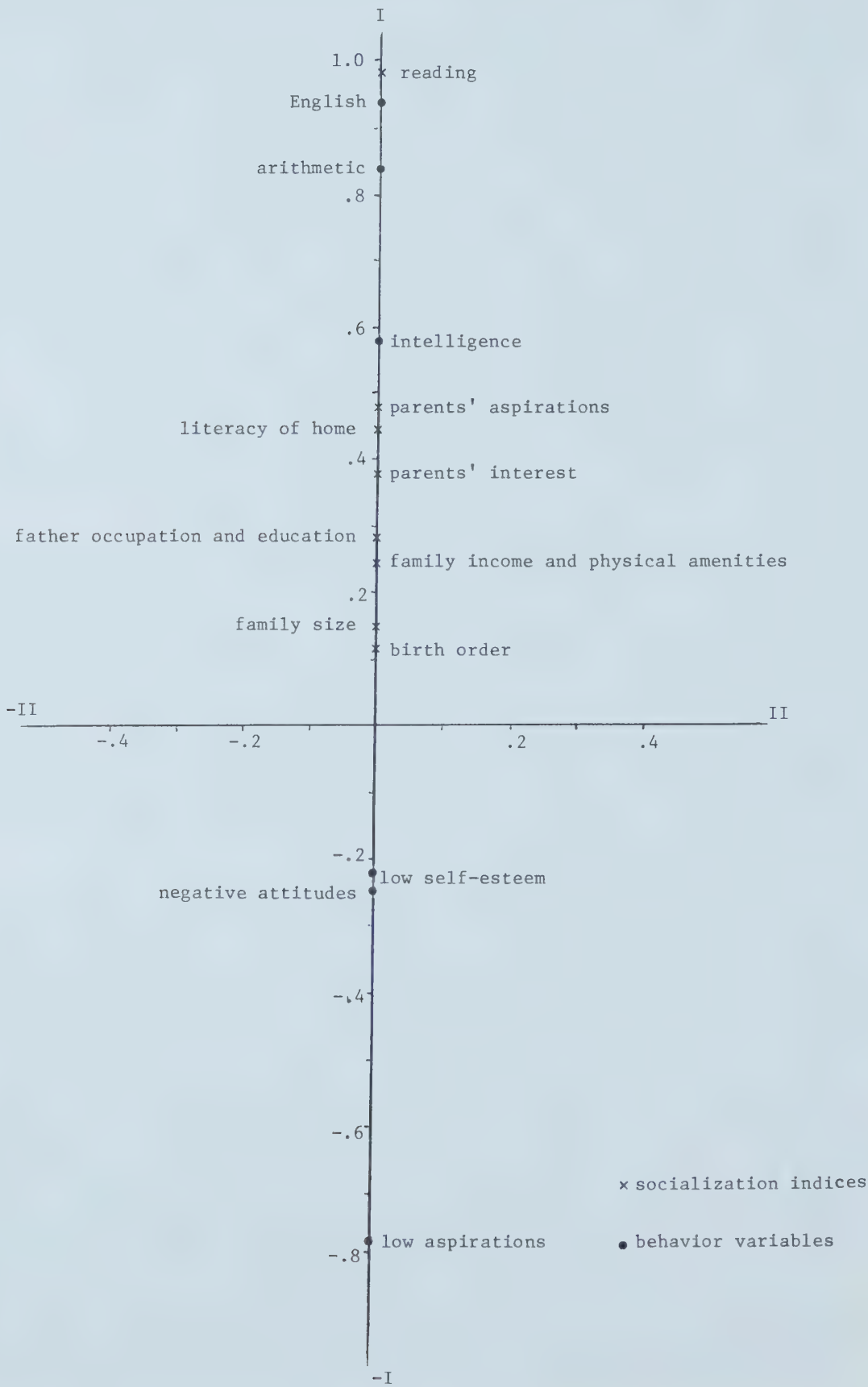
When the data for the boys were examined, only one canonical correlation, .877, was significant (probably less than .001). With respect to the canonical variate which is presented in Figure 2, the loadings suggest that English and arithmetic achievement, aspirations and, to a lesser extent, nonverbal intelligence, school attitudes and self-esteem are related to the proxy socialization index of reading performance, parents' aspirations and literacy of the home. Unlike the relations for the girls, the social status (father occupation, family income, father education) of a boy's family was not a significant predictor of the behavior variables. Instead it appeared that the influence of the structural variables was mediated by the more proximal social-psychological measures.

When the canonical correlations for the girls (.870 and .351) were cross-validated in the boys' sample, correlations of .850 and .140 were obtained while the correlations for the boys (.877 and .207), when cross-validated in the girls' sample, were .870 and .080. The stability of the cross-validated relations between the socialization indices and the behavior variables provide confidence for the validity of the relationships.

In general, the findings indicate that moderate to large percentages of the variance in the cognitive and affective behaviors of adolescents are associated with assessments of the socialization processes in the family. While the proximal socialization indices have greater predictive validities than the structural variables, the canonical analysis indicates the importance of including the social status variables, especially for girls, in the analysis. The greater complexity of the relations for the adolescent girls provides some support for Vernon's (1969) contention that "cause-effect relationships are on the whole more straightforward in the male-sex" (p. 8).

By analyzing longitudinal data and using multiple measures of socialization processes and adolescent behavior, the present study has

FIGURE 2
CANONICAL LOADINGS OF SOCIALIZATION INDICES AND BEHAVIOR
VARIABLES: BOYS



moved beyond much of previous research which has examined the socialization correlates of adolescent behavior. Also, canonical analysis allows for a greater understanding of the interrelations between the socialization processes of the family and measures of cognitive and affective behavior. If our understanding of adolescent development is to be enriched further, we need more research which investigates relations between multiple measures of adolescent behavior and socialization processes that operate in the family, neighborhood and classroom and which are defined in terms of both the structural and social-psychological features of the different environments. Only after such research has been undertaken will we begin to understand the complexity of the interrelationships between technical and moral socialization and adolescent behavior.

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The Alberta Journal of Educational Research

Table of Contents—Volume XXII, 1976

- Adams, G. R., and Cohen, A. S. *An examination of cumulative folder information used by teachers in making differential judgments of children's abilities.* No. 3, September, 216-225.
- Algozzine, R. *The disturbing child: What you see is what you get?* No. 4, December, 330-334.
- Allen, D. I., Hamelin, R., and Nixon, G. *Need for structure, program openness and job satisfaction among teachers in open area and self-contained classrooms.* No. 2, June, 149-153.
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- Lupul, M. R. *The portrayal of Canada's 'other' peoples in senior high school history and social studies textbooks in Alberta, 1905 to the present.* No. 1, March, 1-33.
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- Nachtsheim, N., and Hoy, W. K. *Authoritarian personality and control ideologies of teachers*. No. 2, June, 173-178.
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